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Kingston University London: 20 Years of GIS Education

By Kenneth Field, Course Director, Kingston Centre for GIS

In the United Kingdom, Kingston University London (KUL) holds a special place in the history of academic programmes in geographic information systems. In 1989, Kingston was the first higher education institution (HEI) in the world to design and offer a three-year bachelor's degree wholly in GIS. September 2009 marked 20 years of the course as it comes of age and welcomes its 21st intake.

With more than 650 graduates of the bachelor's degree course, 50 master's graduates, and more than 400 students of our distance-learning training course for professional in-service training, as well as successful doctoral candidates, the university has many students who have gone on to develop careers in the geographic information (GI) industry.

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Willie Smits Shares Methodology for Sustainable Forests

"We can use technologies such as GIS to save biodiversity. We can still help local people retain their cultures and traditional means of existence." This is the message of Dr. Willie Smits, founder of the Borneo Orangutan Survival Foundation and the Masarang Foundation, which raise money and awareness to restore habitat forests around the world.

Smits, a keynote speaker at the 2009 ESRI International User Conference, is a biologist dedicated to rebuilding orangutan populations and improving forest habitats worldwide. His campaign has two fronts. One is a zealous battle against deforestation and habitat destruction, and the other is the promotion of sustainable agribusiness that benefits both species of primates, human and orangutan. "We cannot save the environment if we do not simultaneously take care of people's needs," maintains Smits.

In recent decades, palm oil plantations have become prevalent on the Indonesian islands of Borneo and Sumatra where, for thousands of years, colonies of orangutans have thrived in lush tropical forest. The main goal of the Borneo Orangutan Survival Foundation is to protect orangutans and their natural habitat, but the desecration of this habitat has become so pervasive that the foundation has taken into its care more than 1,000 orphaned orangutans. Scientists estimate that wild orangutans are disappearing at the rate of 2,000 a year and will be extinct in 10 years.

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Portland, Oregon, Trailblazes a Successful Regional GIS

By Matteo Luccio

People from around the world come to Portland, Oregon, to study the city's successful model for growth management and comprehensive land-use planning. Few, however, know that this success is enabled by a regional land information system (RLIS) that was conceived and implemented 20 years ago by Metro, the first elected regional government in the United States, along with cooperating local jurisdictions, to help meet state planning requirements. RLIS has since been the key tool used to plan, evaluate policy, and formulate development models in the Portland area.

Metro, which comprises three counties and 25 cities, secured the funding and political support required for the system, covering 544 square

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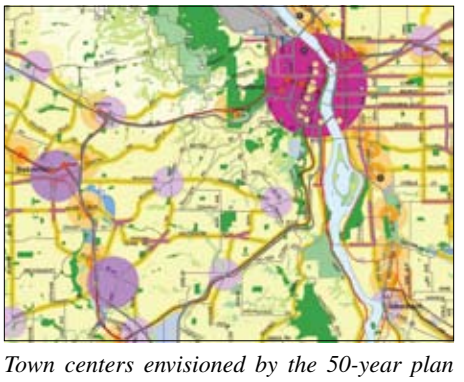

Town centers envisioned by the 50-year plan for managing growth in the Portland metropolitan area.

Design and Collaborate over the Web

Web Editing and User-Generated Content (UGC) at ArcGIS 9.4

ArcGIS 9.4 Web editing will change the way organizations collect and manage spatial data. It gives users the ability to modify geographic content within any Web mapping application and provides a venue for online communities to become active contributors to the geodatabase. Web editing makes it easy to capture ideas and observations for distributed problem solving and extend GIS editing capabilities to more people within the organization. These capabilities can also be used to capture user-generated content (UGC).

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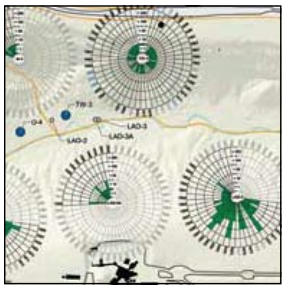
New Web editing capabilities allow citizens to easily share their observations.

Time Awareness Leads to Better Understanding of Complex Geographies

Visualizing Time in GIS



Temporal GIS is an emerging capability for integrating temporal data with location and attribute data, enabling temporal visualization and ultimately temporal analysis. Visualizing change on a computer screen in a GIS environment may give the viewer more options, but it is still a challenge. At ArcGIS 9.4, ESRI has made time a core component of GIS. Simple and easy temporal mapping and visualization functionality means that the map is now time aware. The new time-aware functionality in ArcGIS 9.4 lets users create and manage time-based data, display and animate temporal datasets, and publish and query temporal map services. (*See the complete article on page 12.*)

Special in This Issue

Web Editing with ArcGIS 9.4

continued from cover

Highlights

- Modify or add content via a Web mapping application.
- Provide fast, intuitive editing opportunities for Web users and geodesigners.
- Save time by distributing focused editing tasks over the Web.

What Is Web Editing?

Web editing involves modifying or adding content to the geodatabase via a Web application. Editing is performed using a set of simple sketching tools that allows users to draw new features or edit existing features directly on a Web map. Users can also edit attributes and add attachments, such as digital photos. At 9.4, Web editing capabilities are supported in all client applications, including browser-based applications built with ArcGIS Web Mapping APIs (JavaScript, Flex, and Silverlight/WPF), ArcGIS Mobile applications, and ArcGIS Desktop.

Please see the "ArcGIS 9.4 Web Editing" poster on pages 24–25.

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Custom Web mapping applications and simple sketch tools can be used to update map features.

Web editing is optionally enabled when a map is published to ArcGIS Server. The user can choose to provide feature-level access to the map service while configuring service capabilities. Web editing capabilities include an enhanced geometry service that supports new geometric operations, such as union, intersect, trim, extend, cut, offset, auto-complete, and reshape.

Why Is Web Editing Important?

Web editing provides fast, intuitive editing opportunities for users of the open Web. While they don't replace the sophisticated editing tools of ArcGIS Desktop, Web editing capabilities allow organizations to extend spatial data editing to a larger, more diverse audience. GIS professionals will save time by distributing focused editing tasks that can be handled more efficiently by subject matter experts. In addition, geographic sketching, a central component of the GeoDesign concept, will allow users to quickly sketch their design ideas on top of digital maps and get immediate feedback on the performance or impact of the design being proposed. Sketching enables rapid testing of multiple design proposals and alternatives.

Feature services (services with feature access) provide end users with a simple, easy-to-understand view of the geodatabase. They can interact with individual features, feature attributes, attachments, and relationships to other features or tables and make basic changes to those elements.

Web editing in ArcGIS is template based. At 9.4, feature templates (authored in ArcGIS Desktop) are published with the feature service and carry over layer properties, such as how features are symbolized in the map. Templates also allow the publisher to control which attribute fields can be viewed and edited, as well as provide access to subtypes and domains.

Authoritative data editors can use feature services too, but they are not restricted to the simple Web editing toolset. ArcGIS Desktop users can create a local copy of the service layers, edit features using ArcMap editing tools, then synchronize those changes back to the service via ArcGIS Server.

Who Will Use Web Editing?

One of the fastest-growing audiences for Web mapping applications is Web citizens. Web editing empowers ordinary citizens to contribute their observations by merely drawing on an online map. They can create new features describing the shape and location of a problem or concern. They can attach a photo to the feature or simply take a picture with a smartphone and send it. In this way, people become dynamic sensors moving through the landscape, annotating the map as they go along. Organizations might incorporate these observations to gauge citizen response to a proposed policy or build a new kind of social geography that changes the way leaders look at their communities.

Mobile workers can use Web editing to tap into and edit authoritative datasets on-site. They can quickly improve the accuracy and value of the data with their observations because those changes are synchronized with the GIS server, and the new information is immediately available for others to use.

Similarly, an organization's non-GIS office staff can use internal Web applications to keep feature attributes up-to-date, attach supporting digital documents to a feature, or validate the status of assets and inventories.

GIS professionals, as well as a new breed of geodesigners, will use Web editing to sketch out ideas, create prototype designs, and visualize what-if scenarios. They can take a what-if sketch and turn it into a topologically sound, as-built layer and maintain the entire history of changes and ideas.

Conclusion

New Web editing tools and services available in ArcGIS Server 9.4 allow everyone—from authoritative data editors to citizens on the street—to contribute content to the geodatabase. GIS professionals can proactively shift simple editing workloads to appropriate staff. With this expanded capability, people can share and build a common understanding of the issues affecting their environments and work together to design the best solutions.

More Information

For more information, visit www.esri.com/whatscoming. AN

Kingston University London: 20 Years of GIS Education

continued from cover

At least 10 KUL graduates currently work for ESRI, and many students work for data and solutions providers. KUL GIS graduates are in demand by diverse organizations, including environmental agencies; local government; retail, commercial, mapping, transportation, and utilities organizations; and software firms. One of our first master's graduates, Armen Asyran, recently helped compile *Earth,* which is the world's largest atlas published by Millennium House.

KUL has been a world leader in GIS throughout its first 20 years and firmly intends to remain so. Since the initial decision was made in 1988 to establish the first bachelor's degree course and a centre of excellence in GIS, many changes have taken place, but the current faculty is committed to developing interesting, cutting-edge courses, undertaking research and consultancy, and maintaining and developing links to the GI industry to support common goals.

The GIS faculty at KUL has pioneered a number of developments subsequently taken up by the university. Tim Linsey and Ed Parsons were responsible for making online resources available via the Mosaic Web browser in the early 1990s with GISWWW and its own bulletin board. Parsons also built his own local area network within the university for the distribution of GIS resources. Faculty members are also routinely involved in national-level resource initiatives, such as the development of MasterMap Download, the academic interface for Ordnance Survey's MasterMap data, which faculty helped shape prior to its rollout to all UK universities.

With a strong team of former faculty members and alumni who continue to support KUL, there exists a unique group of academics and professionals who have shaped this major contribution to the development of GIS.

Close liaison with the GIS sector keeps the course current and directly relevant to the needs of employers. Links with suppliers, consultants, bureaus, and a wide range of users have been established, resulting in student visits, internships, and guest lecturers. This collaboration provides crucial support for the course and helps maintain KUL's reputation among employers.

High-quality, externally funded research has characterized the work of the faculty and informed teaching in areas such as remote sensing of hazards and upland forests, spatial statistics and the handling of geographic information, image-based systems, multimedia, and virtual reality development in GIS, as well as the application of GIS to environmental problems. Ongoing is a two-year project to explore use of students' personal technologies for data gathering and sharing and the role of social networking sites, such as Twitter and Facebook, for the creation of collaborative geolearning environments and innovative Twitter maps—which, taken together, I call "cartoblography."

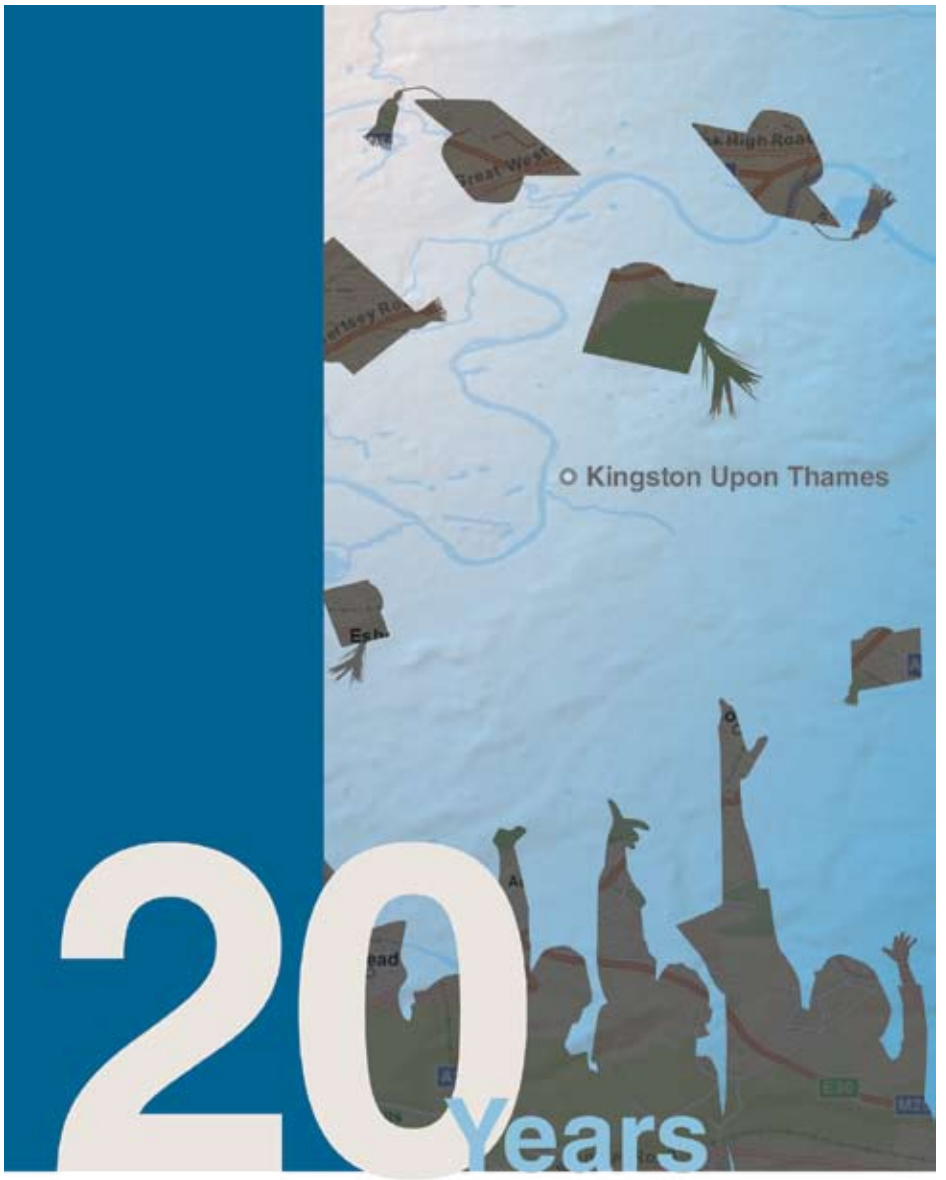

Illustration by Kyle Heinemann, ESRI

Research, Consultancy, and Commercial Links

Under the consultancy name Kingston Centre for GIS, the faculty has delivered training workshops and seminars at GI industry events for the past 20 years, such as the annual Solutions Centre events at UK GIS conferences. The Kingston Technical workshop series is now delivered at the annual Association for Geographic Information (AGI) GeoCommunity conference. KUL also gets involved in GIS Day by hosting a day of events for local schoolchildren, and plans are under way to take part in the National Geographic Society/ESRI GeoMentor scheme. Vanessa Lawrence, CB, Ordnance Survey's CEO and director, is a fellow of KUL and recipient of an honorary doctorate and visits regularly to deliver a keynote lecture that is normally timed to contribute to GIS Day. KUL also supports and encourages growth in GIS courses elsewhere. In 2006, KUL led a major European-funded project to establish a GIS curriculum, course, lab, and staff training at the University of Sarajevo, Bosnia-Herzegovina. KUL also runs an annual GIS summer school in conjunction with AGI.

Commercial and academic links feed directly into the course through our innovative Contemporary Issues in GIS invited-speaker series, which has seen a number of illuminating speakers over the years. Faculty members are also in demand by other institutions as advisers, adjunct tutors, and external examiners, such as Penn State's Masters in GIS (James O'Brien), the UNIGIS MSc programme (Nigel Walford), and the Royal School of Military Survey MSc course in defence geographic information (Kenneth Field). Such networks are important to share expertise, disseminate findings and experience, and support healthy inter- and intrasectoral collaboration.

KUL is also supporting ESRI (UK) Ltd. in developing its Enterprise Training Lab based on applications and student projects developed over recent years.

The GIS Road Map at KUL: Another 20 Years and Beyond

The last 20 years have seen phenomenal change and growth in technology, data, software, and the GI industry. KUL has been part of that growth and has led initiatives to keep courses at the forefront of GIS education. As KUL embarks on the next 20 years, there are echoes of 1989 and the drivers that stimulated the initial development of the course.

Perhaps now, more than ever, an increasingly democratized approach to handling spatial data and mapping has caught the public's imagination and illustrated the power of the geographic approach. Ever more jobs and careers require graduates to be highly skilled and trained professionals in GI systems and science. The impact of online data providers and the rapid diffusion of mobile and Internet mapping applications have reignited interest in the combination of geography and technology that should provide a steady supply of students to courses and serve the now maturing discipline well in the future. Many more pivotal positions in GI-related careers will be needed—careers for people who can now gain professional recognition as Chartered Geographers with expertise in the field of GIS (CGeogGIS).

The recent review and events marking the 20th anniversary of the milestone *Chorley Report on Handling Geographic Information* (1987) in Britain (see below) reaffirmed the position of GIS at the heart of spatial data infrastructures. The Infrastructure for Spatial Information in Europe (INSPIRE) initiative promotes data interoperability and sharing of spatial information and provides a framework across Europe. The newly released *Location Strategy for the United Kingdom* (Geographic Information Panel, 2008) puts the nature of place, where events happen and impact the people and assets at that location, at the centre of national, regional, and local initiatives and service delivery. The purpose is to better plan and to manage risk and use resources more efficiently, maximizing the value of geographic information to the public, government, and UK business and industry.

This is a crucial document in shaping the information economy for the coming years and emphasizes the continued need for suitably knowledgeable and well-trained graduates in GI systems and science. In 2008, GIS was officially included as a core component of the school geography curriculum, meaning that every schoolchild will now be formally introduced to GIS. Along with KUL, other universities and ESRI (UK) are making great strides to support development of GIS at the school level, which should see a thriving graduate and postgraduate market emerge.

The Early Years in Kingston upon Thames: From Idea to Inception

In honor of this 20th anniversary, I would now like to reflect on the history of the course and reveal some of the stories that have characterized GIS at Kingston.

Since 1947, the School of Geography at Kingston Polytechnic had developed a strong reputation for its bachelor's degree course in geography. The cartography component had always been a core component of the course, and staff research interests with Ph.D. awards at the time focused on digital cartography and expert systems. Courses in digital cartography; remote sensing; and, in 1986, an option in GIS were introduced into its geography course. Only 250 metres along the road, the Environmental Studies Department of Kingston College of Further Education (KCFE) had been involved with cartography and related subjects since the 1960s. Demand for suitable qualifications in cartography by people working within established cartographic agencies led to the development of two-year part-time Ordinary and Higher National certificates in 1968 and 1970, respectively. These incorporated all aspects of cartographic practice, theory, and production methods, as well as surveying, photogrammetry, mathematics, and geography.

The rapid expansion of digital cartography in the 1980s and development of the new discipline of GIS had a major effect on the education programmes of both institutions. These developments provided the context for the institutions, in the late 1980s, to jointly develop a new range of educational and training courses in GIS that reflected the strong growth of technology in geography during that decade as geographers sought to develop links between increasingly available data and the computer's ability to facilitate effective storage, manipulation, and analysis. A proposed bachelor's degree course in GIS emerged as a collaborative development concerned with spatial data handling and the application of GIS technologies to a wide spectrum of problems and their solutions. The aim of the course was to enable students to acquire knowledge, skills, and expertise in GIS, integrated with mapping technology, for the purposes of spatial data management.

Justification for the world's first degree course in GIS gained support on the basis of an expanding

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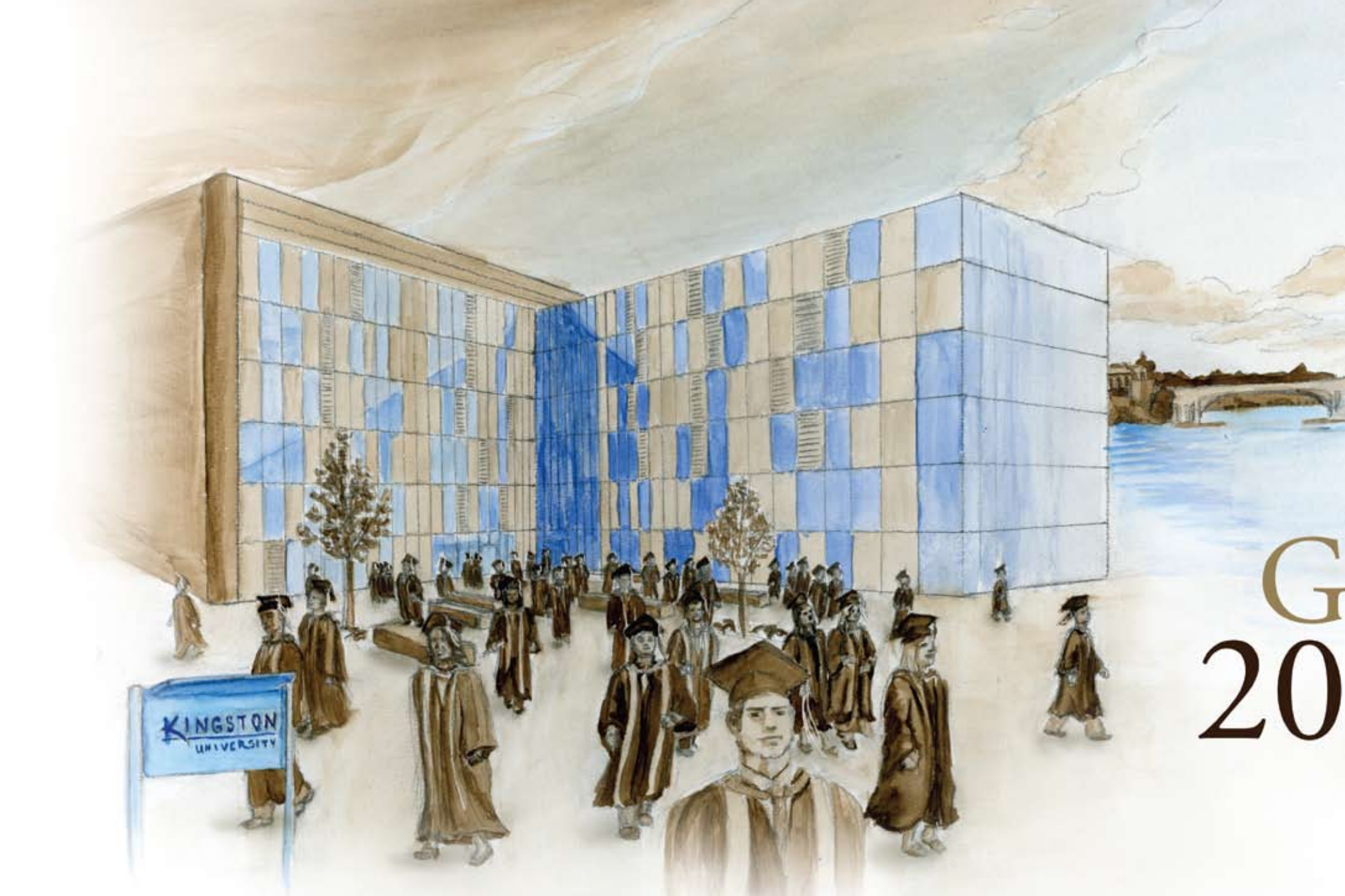

Kingston University London: 20 Years of GIS Education

Illustration by Elizabeth Davies, ESRI

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market for GIS specialists identified in two key publications. Both the 1984 *Report on Remote Sensing and Digital Mapping* (House of Lords Select Committee on Science and Technology, 1984) and the 1987 *Report to the Secretary of State for the Environment of the Committee of Enquiry into the Handling of Geographic Information,* chaired by Lord Chorley, identified the need for degree courses in GIS. The *Chorley Report* particularly stated "it is apparent that there continues to be a serious gap between education and training requirements and actual provision in the geographic handling areas. In our view, this gap is a factor holding back the use of technology for handling spatial data and the shortage of trained personnel could be even more of a constraint in the future as demand increases." The *Chorley Report* concluded that there was "a need to increase substantially, and at all levels, the provision of trained personnel."

Evidence from both the U.S. and UK markets suggested that the rapid expansion of GIS technology would lead to the establishment of whole new GIS-based employment areas, including local government, utilities, commerce (in particular, sales and marketing), and environmental management. The AGI formed as a direct consequence of recommendations in the *Chorley Report* and identified a growth in demand for spatial information, computer systems that utilize this data, and trained personnel who can operate such systems. In the UK, £70M had been spent on GIS technology by the end of 1988, with an annual cost of £30M by the turn of the decade. Many HEIs subsequently incorporated GIS units into existing geography courses, and one-year master's courses began to appear. The appropriateness of the "bolt-on" GIS unit, the problems of what to teach and how to properly resource practical exercises, and the lack of experience within existing staff were all problems that had to be addressed. The need for individuals with multiple skills in underlying subject areas, such as geography, engineering, and business; in conceptual and practical considerations of GIS; and in broader IT and management issues demanded a more substantive educational approach.

At the school level, the inclusion of geography in the national curriculum and the general popularity of the subject was leading to oversubscribed geography degree programmes. The rise in interest in computing and information technology subjects and the increasing role of computers in society also suggested that the development of a new academic course that married these together could provide a popular subject. This potential was supported by the fact that the GIS unit in the geography degree course at KUL was itself oversubscribed.

Market research of 45 leading firms and establishments that had some involvement with GIS found overwhelming support for a bachelor's degree course and a growing need for graduates. Further support and advice on the course design were received from the AGI, British Cartographic Society, British Computer Society, and Ordnance Survey. The survey response was also crucial in the naming of the course, a decision which, with hindsight, was remarkably astute. The course was originally to be titled *Environmental Information Management and Mapping Systems.* On recommendation, the title changed to *Geographical Information Systems,* reflecting a terminology that was to become ubiquitous. With impetus established, a committed group of people in the School of Geography at the Polytechnic, alongside staff from KCFE, prepared course documents in January 1989 that were ratified by the Council for National Academic Awards (CNAA) in June. The first intake of 35 students in September 1989 was impressive for such an innovative course and fully justified its development.

Within two years, there were more than 40 students majoring in GIS, and in 1991, a Higher National Diploma (HND) course in GIS was added to its portfolio, with an intake of 20. In 1992, the Polytechnic was granted permission to become a university, and Kingston University London was born as the first cohort of students graduated with the highest student retention rate in the university, along with the highest level of graduate employment within six months of taking the course. By 1997, there were approximately 70 students per annum studying GIS.

The aim of the bachelor's degree course was to provide students with the skills and understanding necessary to apply GIS technology to a wide range of environments. This provided a framework for understanding GIS concepts and how they are integrated into broader information technology strategies. Objectives were to

- Provide an interdisciplinary and integrated approach to GIS.
- Develop critical and analytic skills for problem solving through the use of GIS.
- Enhance students' ability to undertake effective decision making.
- Develop skills in evaluation, application, and management of information systems.
- Provide a sound understanding of the role of spatial data in decision-making processes.
- Understand the business, social, and environmental implications of GIS.
- Provide students with a range of skills and knowledge to undertake a range of GIS-related jobs.
- Help students adapt to the rapid changes taking place in information technology and be able to respond flexibly and positively.

Course content was organized around four underlying themes. The environmental information theme examined sources and character of social, economic, and physical data operating over various spatial and temporal scales and their measurement and description. Information collection methods covered principles of data collection and capture, photogrammetry, remote sensing, surveying, and social and economic surveys. Data analysis explored GIS and other information systems for data management, intelligent data manipulation, spatial and statistical analysis, and system design and evaluation. Finally, information management and communication focused on cartography and digital mapping, report compilation and desktop publishing, management, and budgeting implications. The course engendered an applied philosophy so students gained knowledge and understanding of the application of GIS to effectively examine and solve spatial questions.

Back to the Now

The general framework survives to this day, though the balance and course content have changed considerably to both reflect developments in

IS years

GIS and lead curriculum initiatives in the science and delivery of GIS. Core modules in GIS are now delivered to all students of geography, environmental science, geology, and forensic science in Year 1 (approximately 250 students). This reflects the maturation of GIS as a discipline and the enabling role it plays for all geoscience subjects. It also reflects the philosophy of embedding GIS as a framework for study across a range of subjects in the university that extends to landscape architecture, computing, business, and surveying. Modules in photogrammetry and topographic techniques have long gone but have been replaced by emerging areas, such as mobile GIS and GeoWeb applications, which keep the course on the cutting edge.

The current curriculum introduces GIS across four Year 1 modules: Digital Earth, GIS Techniques, Applications of Geoanalysis, and Fundamental Programming Concepts. In Year 2, modules offered include Digital Mapping, Remote Sensing, Spatial Databases, Geographical Analysis and Modelling, GIS Software Development and Customisation, GIS for Enterprise and Research, and Mobile GIS. The final year promotes specialties in a wide range of options, including geovisualization, GeoWeb applications, crime pattern analysis, GIS and health, GIS and hazards, systems analysis and design, high-definition surveying, and geodemographic analysis. The bachelor's degree course now also has Joint Honours options where students can combine a major in GIS with a minor in computing, Web technologies, business administration, or landscape architecture. This provides tremendous scope for linking GIS with a range of other subjects at KUL.

In 2003, fieldwork was embedded into the programmes to take GIS out of the classroom, and this has since provided a focus for some innovative work in mobile GIS, fast becoming a contemporary area of expertise at KUL. Current curriculum initiatives are focusing on server-based GIS both in class and for mobile GIS and high-definition surveying with terrestrial lidar for data gathering, handling, manipulation, and visualization.

Alongside the bachelor's degree course, KUL has successfully delivered a Continuing Professional Development (CPD) distance-learning training course for professional in-service training since 1994. This is a nonaccredited option that many hundreds of employees have studied part-time in distance-learning mode. Despite preeminence in the provision of a bachelor's degree course, it wasn't until 2002 that KUL added a master's programme to its portfolio. The Masters in Applied GIS combined a major in GIS with a minor in environmental science. In 2008, provision was extended by the addition of a distance-learning Masters in GI Systems and Science. Both programmes are recruiting strongly as GIS becomes ever more pervasive in a wide range of activities that require professionals to retrain and seek professional development and qualifications in GIS.

KUL will continue to support state-of-the-art GIS education and make it available to all those who join the world's first GIS course as it embarks on the next 20 years.

ESRI Development Center

KUL is also extremely proud of its recent accreditation as an ESRI Development Center (EDC), which provides recognition and special status to university departments that have exemplary programs. Being an EDC site brings a number of benefits, including an annual student of the year award that was conferred for the first time in 2009, suitably commemorating 20 years of the course.

The 20th Anniversary Celebration

To celebrate the 20th anniversary, KUL will be holding a reunion reception for past and present GIS staff, alumni, and current students in 2010. For details of the event, contact Dr. Kenneth Field through the Kingston Centre for GIS Web site (www.kingston.ac.uk/centreforGIS).

Changing Faces of GIS Faculty, Keeping Pace with Change, and Recognition and Rewards

Many people have contributed to GIS at KUL. Some remain, while some have moved on and made other significant contributions in academia and business, leaving openings where new faculty have taken up the reins. KUL has also benefited from its relationship with a number of major figures in GIS over the years. A substantial financial commitment was made in terms of staffing and computer technology to launch the course. This was vital to success, and resourcing remains a vital aspect of quality course provision. Over the years, the Kingston Centre for GIS has frequently been recognized and honored. Visit www.esri.com/arcnews or www.kingston.ac.uk/centreforGIS for a list of key individuals, important technology, and awards.

Kingston University London
Centre for GIS
www.kingston.ac.uk/centreforgis

Acknowledgments

Many thanks to all those past and present faculty members who contributed to this review. As ever, it's a team effort.

About the Author

Dr. Kenneth Field is course director and principal lecturer at Kingston Centre for GIS, Kingston University London. He has been editor of *The Cartographic Journal* since 2005 and is a member of the Council of the British Cartographic Society. His teaching and research focus areas are cartography and geovisualisation, as well as mobile GIS and mobile mapping.

More Information

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Portland Trailblazes a Successful Regional GIS

continued from cover

Highlights

- RLIS has provided planners with a new set of tools based on GIS.
- A primary purpose of RLIS is to monitor land development and future growth capacity.
- Any jurisdiction that contributes data to RLIS gets free RLIS data.

miles, through two visionary arrangements. First, it convinced the region's electric utility company, PGE, to share its CAD file of tax lot boundaries. In return, Metro would return the file to PGE in GIS format and produce quarterly updates.

Second, Metro offered to share its system with the cities and counties in its jurisdiction in exchange for their agreement to maintain the data and give Metro periodic updates. To gain support from Metro's leadership, the project team quickly produced a map to demonstrate the system's capabilities.

Metro also engaged in entrepreneurial efforts to generate revenue to cover approximately 40 percent of RLIS' maintenance costs. The business community supported these efforts, because they would allow Metro to produce the accurate and timely data it needed.

From the beginning in 1989, Metro standardized RLIS on ESRI products and developed data standards cooperatively with its local partners. Today, real estate and development companies routinely purchase RLIS data and use Metro's map Web site. Emergency management agencies pay Metro to maintain their street address files. To partly automate public access to RLIS data, Metro has developed a Web interface and sells annual subscriptions to the RLIS Lite quarterly CD-ROM series.

Planning in Oregon

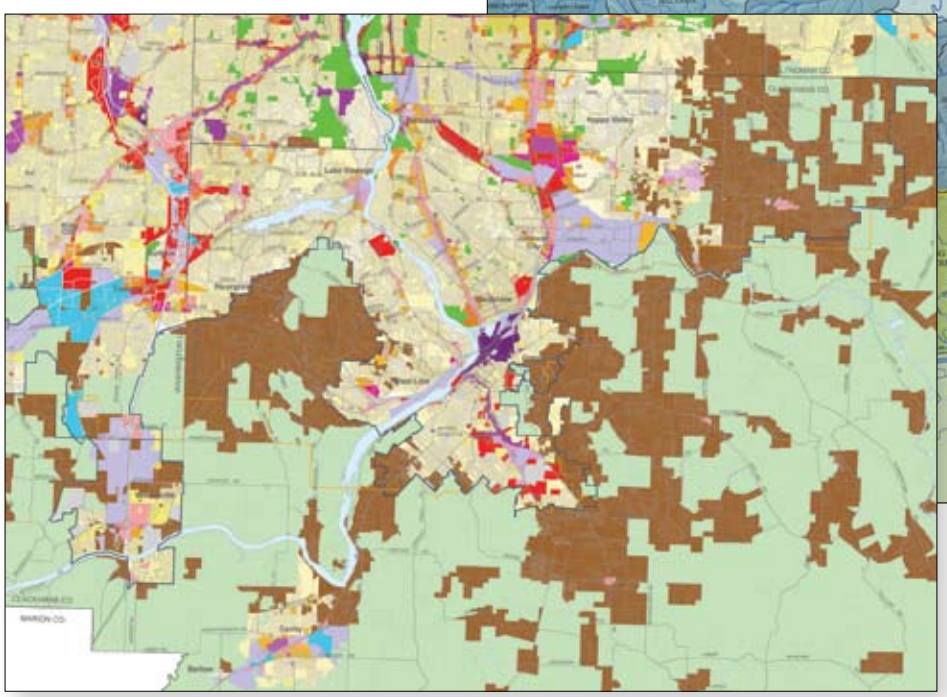
In 1973, Oregon mandated all jurisdictions to develop comprehensive plans, and the next year it required every incorporated city to adopt an urban growth boundary (UGB) encompassing a 20-year reserve of land. Responsibility for the Portland UGB falls on Metro, which serves more than 1.4 million residents. In the early 1980s, Metro began to develop transportation models and forecasts; in the late 1980s, the statewide planning law required it to review its UGB, and it began to develop regional urban growth goals and objectives; and in 1992, Metro and the local jurisdictions began a planning process that led to the adoption of a 50-year vision for urban growth within Metro's boundaries.

RLIS

RLIS was started as a pilot project in 1989, and an operational GIS was ready early in 1991—that is, RLIS was born at about the same time as this planning process and yielded its first products at about the same time that the urban growth goals and objectives were adopted. Using RLIS to drive transportation and air quality models using parcel-level data for the first time, Metro was able to test alternative growth scenarios.

Metro designed RLIS in collaboration with planners, with the aim of identifying the requirements of a GIS that would support both community and regional planning and provide consistent land information across jurisdictional boundaries.

For the basemap, regional planners preferred a much cheaper and simpler zonal system, using U.S. census tracts or traffic analysis zones. However, planners for local jurisdictions, whose financial support was essential for RLIS, preferred one based on tax lots, which would enable community-scale planning and linking tax lots to county assessor records. Therefore, the regional planners agreed to take on the huge task of building a tax lot-based GIS. Twenty years later, Metro now depends on this level of acuity for such projects as land-use forecasting.



A map of zoning classifications, made possible at this level of detail by RLIS

To accomplish that task, Metro then outsourced the conversion from CAD to GIS of PGE's tax lot data, which took 16 months. The polygons were assigned tax lot ID numbers, linking them to tabular tax assessment records. The Oregon Department of Transportation provided street centerlines, street names, city limits, rivers, and other layers. Streets are now the alternate base layer in RLIS and are used for vehicle routing, thematic mapping, census data, and transportation analysis zones.

A primary purpose of RLIS is to monitor land development and future growth capacity. To accurately identify vacant land, since 1991 Metro has relied on annual true-color digital orthorectified aerial photography for the region. Each year, two GIS technicians spend two months updating the inventory by overlaying current building permit records over aerial photos and applying strict rules to determine whether a tax lot is vacant, partly vacant, or developed.

GIS Powers the Model

At first, Metro's Data Resource Center (DRC), which created and manages RLIS, used all the ESRI GIS tools then available to build and maintain the main RLIS components, such as boundaries, streets, and tax lots. Metro took advantage of ArcView software's shapefile format to release RLIS Lite in 1996, which allowed it to distribute the data, without tiling, in a format that could be used by a wider audience. In 1998, Metro used MapObjects to write an application for its Recycling Information Center.

Metro was an early adopter of ArcSDE in 1998 and for 10 years used it for data publishing only. In 1999, it installed ArcIMS, which served ArcSDE layers to the public. From 2000 to 2008, Metro worked on converting its legacy ARC Macro Language (AML)/coverage processes to ArcGIS, and by 2008 it had converted all editing to a multiuser geodatabase. Metro also frequently uses ArcReader, ArcGIS Spatial Analyst, ESRI Business Analyst, and ArcGIS 3D Analyst for its project-level work.

Now the DRC devotes about half its staff time to serving the internal data and mapping needs of Metro departments, about a third to serving the needs of partner jurisdictions, and about a tenth to providing services to the public.

Key Factors

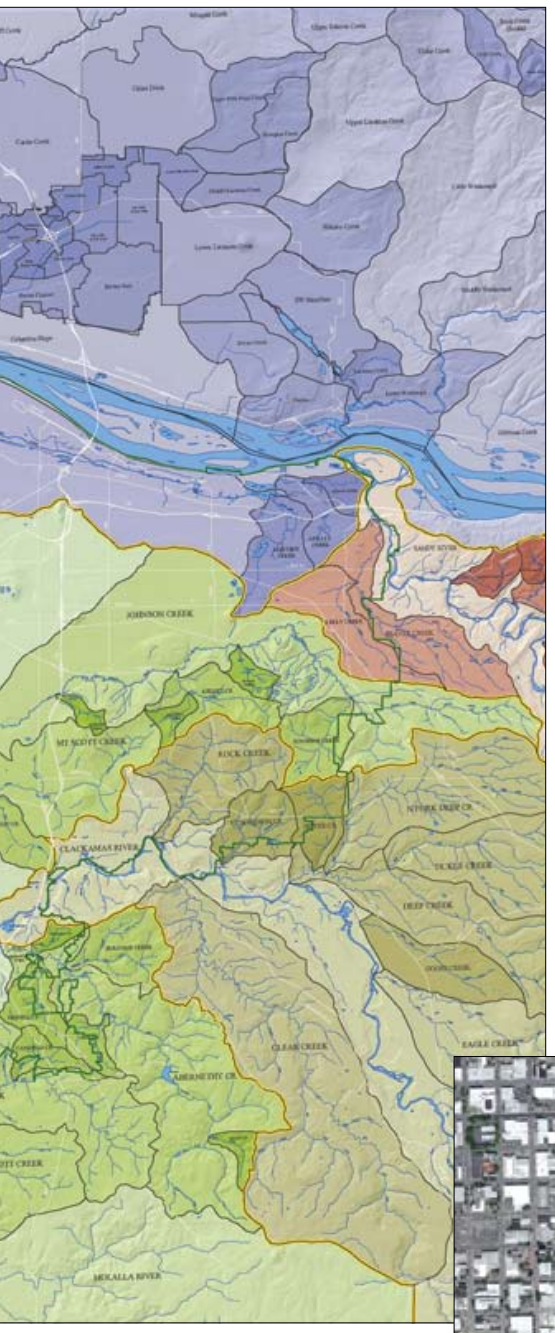
A unique combination of factors required and enabled the development of RLIS and its successful implementation:

- *Public policy*—The state mandated UGBs and a process of periodic review.

The People Behind Metro's RLIS

RLIS came into being principally through the efforts of the following people:

- **Dick Bolen** was a geographer, had been a planner, and was very knowledgeable in GIS. He had a good budget and great support from the Metro Council to make GIS into a useful planning tool. He set up RLIS with all the information a planner would want.
- **Alan Holsted** did maps by hand from 1972 to 1988, using Mylar, pen and ink, and Zipitone. According to Bolen, Holsted "is the unsung hero of all this, the guy that really was doing the work." Bolen and Holsted demonstrated RLIS to the legislature to obtain an exemption from the public records law so that Metro could sell RLIS products.
- **Andy Cotugno,** who was Metro's transportation planning director, made the strategic decision to fund the development of RLIS.
- **John Fregonese,** who was Metro's planning director, was one of the first RLIS users.
- **Bob Haas,** who worked for Washington County, helped Bolen get RLIS started, and his county was the first jurisdiction to get on board. He came up with a "responsibility matrix" that spelled out the role of each jurisdiction.
- **David Asherman** produced great maps using ArcInfo, which elevated RLIS in front of the Metro Council and showed how GIS could be used. "His nickname was Picasso," says Bolen.
- **Ethan Seltzer** was hired at Metro in 1988 as the land-use coordinator.
- **Dale Himes,** at David Evans and Associates, Inc., converted the PGE data from CAD to GIS.
- **Marshall Payne** was a principal at GeoNorth, LLC, an ESRI Business Partner, which wrote code for RLIS.
- **Ray Phelps,** then assistant to Metro's executive officer, Rena Cusma, secured funding for RLIS, mostly out of the budget for the agency's solid waste department.



Watersheds in the Portland metropolitan area, which is located at the confluence of the Columbia River and the Willamette River.

- *Geography*—The Portland metropolitan region encompasses four counties and 26 cities (i.e., Metro's jurisdiction plus the city of Vancouver, Washington, and Clark County, Washington).
- *Technology*—GIS was emerging as a mature software in the 1980s.
- *Data*—PGE had then recently digitized the tax lot lines for its five-county service area. The data has been regularly updated since.
- *Main funding sources*—Seed money came from Metro's budget, contributions from local governments, federal funds for transportation planning, and sales of RLIS products.
- *People*—The success of RLIS is largely due to its key champions, who understood planning and demonstrated the value of GIS to local decision makers.

Key Operational Choices

A few early operational choices by Metro staff members were key to the success of RLIS. First and foremost, they decided to build a GIS, rather than a CAD system, despite the fact that Multnomah County, which had already invested millions of dollars in its CAD systems, pushed Metro hard to follow that path. In addition, they chose to take on parcel-level data and set up the data model cooperatively with the local jurisdictions, which then all adopted it. The local jurisdictions provided quarterly the data they produced in the normal course of business, which the DRC then stitched together and returned to the jurisdictions in the form of the whole region, without any money changing hands.

From the start, Metro has collected data for each RLIS layer from the agency that relies on it the most and built only the layers that it can reliably maintain. A regional GIS steering committee has fostered regional cooperation, and Metro has kept the structure of RLIS as stable as possible to enable comparisons over time. Another vital decision was to set up an aerial photography consortium to buy a single annual flight for the whole region, which ensures consistency and greatly reduces costs.

Aerial photo of Portland's Ladd's Addition residential district.

What RLIS Has Made Possible

RLIS has enormously impacted planning in the Portland area, and many applications have been built on top of it. It keeps people from getting into useless arguments by providing a very transparent and peer-reviewed fact base.

RLIS has provided planners with a new set of tools that enables them to model, simulate, and plan future land development in detail—including the first parcel-level basemap and land-use maps for the region; new mapping and analytic tools that enabled the growth concept to emerge at the parcel level; and many new ways to measure and monitor environmental, social, and economic variables.

RLIS has also enabled the creation of new tools for citizen involvement, including modeling that shows the impacts of user-defined land-use policy choices, and has created opportunities for entrepreneurs, such as way-finding software.

Additionally, RLIS combines the information about parcels, such as assessed land values, sales values, and property taxes, with regulatory and environmental variables, such as zoning, floodplains, wetlands, and slopes.

Finally, cities and counties have incorporated RLIS data into their planning information database, developers use Metro's vacant lands inventory to find land available for construction, environmental organizations and neighborhood associations use RLIS to map out their strategies, and consultants and scholars use RLIS for policy analysis and research.

The Future of RLIS

Metro's staff is reevaluating the methods it uses to maintain and distribute RLIS data and is moving toward a more enterprise-centric model, with a central multiuser geodatabase at the hub. This will allow Metro to maintain data and distribute it to partners and subscribers on a more frequent schedule. Distribution methods will include ArcGIS services, direct FTP downloads, and direct network connections to the server. These different forms of connectivity will also lay the groundwork for experimenting with distributed editing with local data partners.

In the future, RLIS might allow users to edit and download data directly, through a server. New uses of RLIS might include gathering information about energy consumption and carbon emissions at the building level. Some hope that, ultimately, RLIS could be continuously updated and serve data as a service.

About the Author

Matteo Luccio is the president of Pale Blue Dot Research, Writing, and Editing, LLC (www.palebluedotllc.com), which specializes in public policy and geospatial technologies. He has been writing about geospatial technologies since 2000 for eight different technical publications and was previously a public policy research analyst for a private think tank and for state and local government agencies.

More Information

For more information, contact Paul Couey, manager, Metro Data Resource Center (e-mail: paul.couey@oregonmetro.gov, tel.: 503-797-1897, Web: www.oregonmetro.gov/drc), or Matteo Luccio, president, Pale Blue Dot Research, Writing, and Editing, LLC (e-mail: matteo@palebluedotllc.com, tel.: 541-543-0525). To view a longer version of this article, visit www.palebluedotllc.com. AN

Willie Smits Shares Methodology for Sustainable Forests

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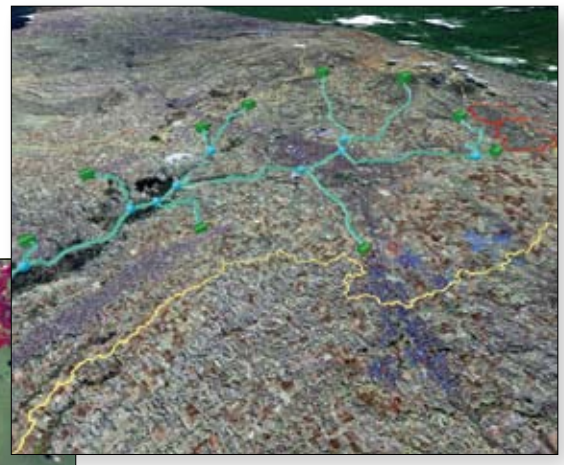
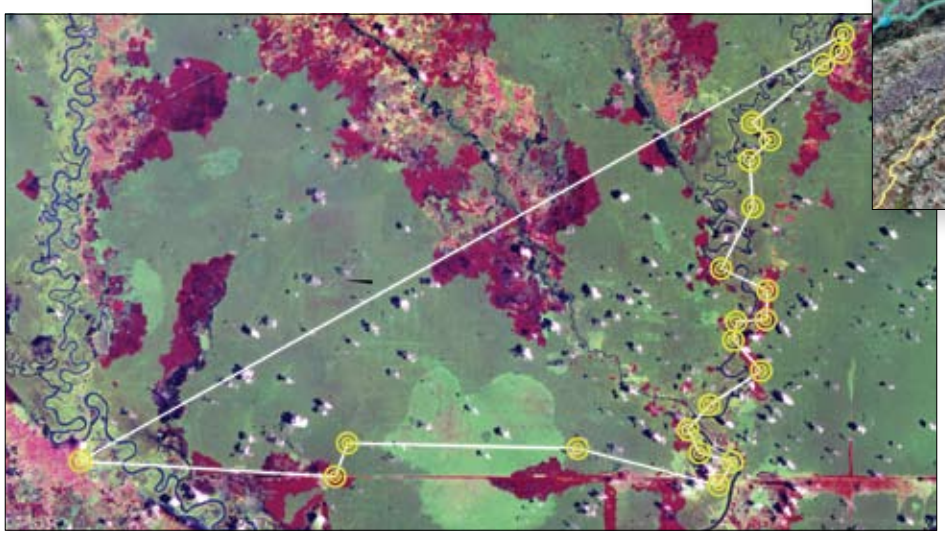




Left: GIS combines Landsat, flyover route, and aerial imagery data to reveal locations of probable illicit timber operations (yellow circles). Above: Tube network gravitationally transports sugar palm ethanol product from village production centers to the coast for shipping.

Smits identifies the harvest of palm oil as the main cause of the destruction of Indonesia's ecosystems. Palm oil, easily grown in these areas, is used in a wide range of products from cookies to cosmetics. Demand is high, making the oil palms a major cash crop for Indonesia, but it is not a sustainable product to harvest. Illegal logging, clear-cutting, and uncontrolled burning associated with oil palm operations destroy the tropical rain forests and severely threaten the orangutan population with extinction. "Destroying forests leaves orangutans with no food and no place to run," says Smits. Furthermore, oil palm tree cultivation provides an easy inroad for illegal logging of other valuable rain forest timber and opens access for the atrocities of animal trade.

Smits combines satellite imagery and GIS to show changes both on forests and on humans. It is used to challenge the hypothesis that Borneo can indefinitely continue to support oil palm plantations; show the profit and cost factors of these sites and their proximity to transportation and shipping; assess the precision farming factors of soil, elevation, and climate and their relationship to and infringements on local communities; and disclose property ownership disparities. In Sumatra, he deployed SPOT imagery at one- by one-kilometer resolution to show how forests are receding and ground cover is changing from trees to shrubs and weeds. It is also used to reveal corruption by showing where companies say they are cultivating palm oil but are, in fact, clear-cutting high-quality rain forest. Some images reveal conspiracy between timber and oil palm businesses running covert timber operations. Flyovers above suspect areas provide aerial images that pinpoint logging equipment in areas where it should not be. The eye-of-satellite imagery and the analytic ability of GIS reveal these schemes and force the hand of law enforcers to take action.

Moreover, imagery and GIS are proven tools for convincing various governments of the world that palm oil consumption is indeed destroying these precious forests. "By using GIS, I was able to demonstrate in a very convincing way that people were misusing oil palms to get their hands on timber," says Smits. "More than half of permitted oil palm plantations are located on unsuitable land for oil palms. They are located in areas where other highly profitable timber grows. GIS is extremely important for visually relaying this information. I don't need to give complicated explanations of the problem because people can easily understand what is happening from our maps. They see how fast the forest has shrunk in just 3 years. This leads them to wonder what the rest of the world will look like in 10 years."

The Advantages of Sugar Palm Trees

Because the Indonesian economy is so tied to the cultivation of palm oil, Smits must do more than preach conservation—he has to promote an economically feasible alternative. Smits studied sustainable options and cited the sugar palm tree, which is a multipurpose plant that is edible and can be used for creating ethanol. "It uses little water, needs no artificial fertilizer, and is six times as productive as sugar cane," claims Smits. Since harvesting processes tap the juices of the sugar palm's flowering branches rather than destroying the entire tree as does palm oil harvest, the process retains the forest's integrity.

GIS is part of the sugar palm remediation plan. It helps direct the activities of a cooperative of more than 6,200 farmers and shows them where and when to extract the palm's liquid. It also shows the best roads for oxcart and automobile transport, processing points in the village hubs, and pipeline placement for gravitational transmission of the product down to the coast for export. GIS shows microclimates and different soil types, as well as predicts yields. These outcomes become the source for determining the amount of labor needed for planting and cultivation.

"We have mapped all of Borneo's forests to study the suitability of sugar palms," Smits explains. "We are using these same processes in other parts of the world, such as in Colombia, where we have a pilot project that includes one million sugar palms. We are looking at the worldwide potential, looking where the temperature and rainfall are sufficient, the infrastructure is in place for cultivation, and the human resources are large enough to perform the labor-intensive tapping processes. We have located many places throughout the world where sugar palms can be planted without depleting the soil. Among the GIS design tools are models for assessing site suitability and predicting impact on local hydrology, carbon storage, and the biodiversity of the area. GIS also indicates the best location to plant the palms and when it is seasonable to do so. GIS is a valuable tool for showing what has happened and designing plans for change."

More Information

Read more about the Borneo Orangutan Survival Foundation at **www.savetheorangutan.org** and the Masarang Foundation at **www.masarang.org**. Download Willie Smits' Keynote Address to the ESRI International User Conference plenary at **www.esri.com/events/uc/agenda/plenary**. AN

Mukund Rao Steers Data and GIS for Global Spatial Data Infrastructure

Mukund Rao is a GIS Hero.

A geologist by education, Dr. Mukund Rao understands how studying the earth can uncover solutions to problems that affect people all over the world. His passion for understanding the earth and its activities led Rao to a rich career furthering earth observation, GIS, and spatial data infrastructure (SDI) applications at both the national and international levels.

To honor this exemplary work record for the past three decades, Rao has been bestowed two honors, the 2008 National Geospatial Award for Excellence from the Indian Society of Remote Sensing and the Exemplary Service Medal from the Global Spatial Data Infrastructure (GSDI) Association. The Indian Society of Remote Sensing recognized Rao's outstanding contributions in promoting geospatial science and technology and applications in India through longtime association and involvement in GIS technology, including his current position as president and chief operating officer of NIIT GIS Limited (ESRI India). The GSDI Association recognized Rao for his role in building and developing GSDI in its formative years and steering its activities as its first president from 2004 to 2006. Rao served as president at the GSDI-7/8 conferences in Bangalore, India/Cairo, Egypt, and has been involved in directing and furthering the technology and application of SDI throughout the world.

"To me, these awards are a humble reminder of the opportunity I've had to work with GIS right from the beginning," says Rao. He was introduced to GIS in 1984 while working at the Indian Space Research Organization (ISRO) to create the first prototype of the Natural Resources Information System (NRIS), a solution for handling images, making thematic maps, and supporting decision making in natural resources management. Rao conceptualized and performed an initial study for the Mineral Exploration Information System (MEIS), which was an integration of images with geophysical and geochemical data that allowed analysts to find mineral indicators. Rao discovered GIS through a course introducing the fundamental concepts of GIS in Mumbai, India, led by one of the early originators of GIS, Dr. Duane Marble, professor emeritus of geography at the Ohio State University. Later, in 1987, Rao was exposed to an excellent training suite in GIS at the Asian Institute of Technology (AIT).

In 1985, Rao was involved in the process of selecting the best-suited GIS package for the support of India's remote-sensing applications and the NRIS program (finally, ISRO selected PC ARC/INFO, then the later versions of ArcInfo). "The innovative methods of handling maps, building spatial models, and creating different spatial perspectives captivated me right away—I could easily perceive their importance and relevance due to my background in geology, where maps and visualization are the key," adds Rao. He went on to apply GIS to urban and regional planning and wasteland management in many cities in India. Ultimately, he became the lead in the NRIS program of ISRO and was instrumental in developing the comprehensive NRIS Standards for GIS in India and, more recently, the National Natural Resources Management System (NNRMS) Standards, the national standards for EO and GIS.

During the late 1990s, Rao realized that SDI was the path for both the NRIS and ISRO imaging programs, conceptualizing India's NSDI program and transforming it into an intergovernmental mechanism. Rao was the key person in authoring the *NSDI Strategy and Action Plan* and prepared the NSDI Metadata Standards. To demonstrate the first GIS portal for NNRMS, Rao developed a prototype that was officially launched and hosted on ISRO's Web site in early 2000. Soon after, he steered the concept of agency SDI portals through the National Urban Information, NNRMS, and a number of state-level portals of SDI, bringing about an integrated system for India's NSDI. This system is now becoming the foundation of NSDI in India. He is currently working on concepts for SDI Applications Portal services and enabling a cross-linking network of application visualization for SDI.

This activity launched Rao into the GSDI movement, and he was elected as the first president of the GSDI Association. During this time, GSDI was incorporated and its activities defined, including a coordinated approach furthering SDI throughout the world through cookbooks, ESRI grant projects, conferences, and committee activities.

In 2005, Rao took over as CEO of Navayuga Spatial Technologies, an Indian startup company located in Bangalore, and headed up many successful projects, including the establishment of an ArcGIS software-based enterprise solution for the Ras-Al Khaimah emirate in the United Arab Emirates (UAE) and the largest enterprise solution project in India, the creation of an SDI in Delhi.

Since joining ESRI India in 2008, Rao has been involved in furthering GIS throughout India by promoting efficient and successful business models. With a deep understanding of earth observation and GIS, ESRI India now operates and helps many successful GIS projects in India and other parts of the world, focusing on urban, power, utilities, disaster, and imagery sectors.

Rao is quick to point out that his associations with other leaders in the field have helped him achieve his successes in spearheading the movement of GIS and remote sensing to assist in solving the challenges faced in the world. Jack Dangermond, president of ESRI, and Dr. Krishnaswamy Kasturirangan, the former chairman of ISRO and chairman of the Planning Commission of India, are two such leaders. Rao also credits a large number of professionals that he has worked with in India and abroad for his GIS accomplishments, learning from their capabilities and expertise in undertaking GIS activities in a better and meaningful way.

Rao is a strong believer that GIS representation will be a key factor in most human activities and a benefit to society and humanity, providing the key technology necessary for information processing and visualization. "While, on one hand," says Rao, "GIS will become easier and simpler to use—thus making it usable by the common man—it will also become integrative and overarching to bring together various technologies of surveying, imaging, and mapping for GIS content; databases and warehousing for GIS storage; and seamless data fusion and merging for GIS applications. Finally, it will provide a tremendous way of visualizing information in a spatial domain. No longer are maps the only output from a GIS."

More Information

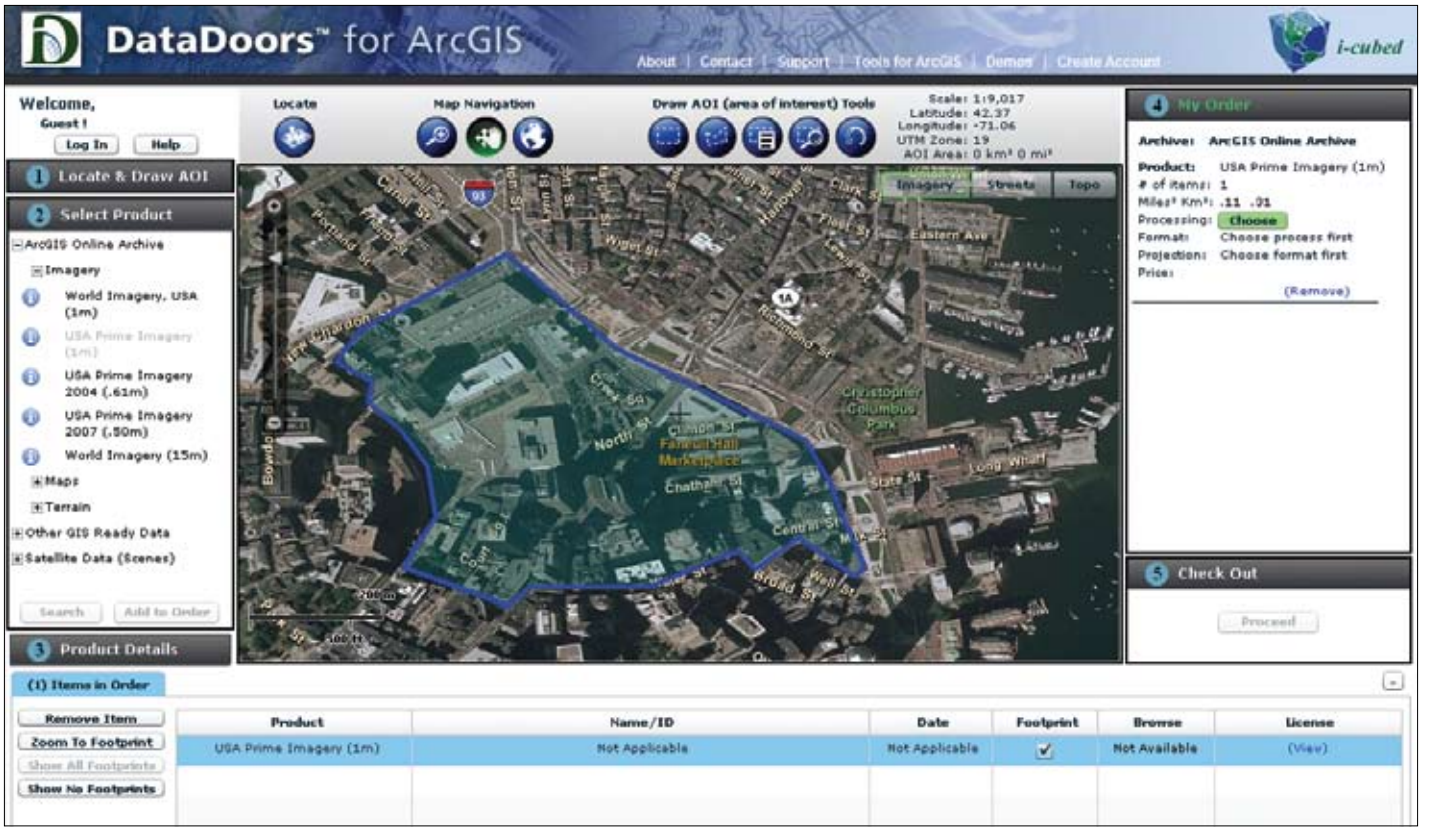
For more information, contact Mukund Rao (e-mail: Mukund.rao@niit-tech.com).

DataDoors for ArcGIS: Geodata On Demand

Get Full-Resolution Original Imagery and Terrain Data for Offline Use

Highlights

- DataDoors for ArcGIS lets users obtain the exact data they need.
- The application is designed for users who need preprocessed data in offline applications.
- Users can access a variety of data from various providers.



Seamlessly preview, purchase, and download original preprocessed data for offline GIS projects.

Advanced GIS work often requires original preprocessed imagery that can be more easily customized than cached tiles. DataDoors for ArcGIS allows users to explore and obtain this kind of data for offline use. This application, created by ESRI and i-cubed, an ESRI Business Partner, provides the source data used to create ArcGIS Online map services, in addition to extensive archives of data from major satellite vendors to use locally for analysis or offline applications.

DataDoors for ArcGIS is ESRI's marketplace for users to view and retrieve original full-resolution data. Instead of having to connect to the Internet and consume cached tiles, users can purchase a specific subset of the source data.

Currently, DataDoors for ArcGIS offers the raster data used for imagery, topographic, and elevation data available in ArcGIS Online map services, along with source satellite, aerial imagery, and terrain data from a variety of providers. In the coming months, the application will also provide access to vector datasets, such as streets, roads, boundaries, and parcels.

The flexibility of DataDoors for ArcGIS allows users to obtain the exact data they need by selecting the specific area of interest (AOI) and the format in which they need the data. Users may also download a toolbar extension for ArcGIS that allows them to seamlessly move an AOI created in ArcGIS Desktop to the DataDoors for ArcGIS Web interface for instant ordering.

Before selecting the data they would like to retrieve, users can view and compare the various datasets available in DataDoors for ArcGIS. Once they determine their AOI and select the type of data they need, users select the coordinate system and file format in which they would like to receive the data. To purchase the data, they simply enter either a credit card or PO number. Depending on the size of the order, users can download the data right away via FTP or have it shipped to them on DVD.

The source data and raw satellite imagery offered through DataDoors for ArcGIS is ideal for ArcGIS users that need to do imagery processing, photointerpretation, or other advanced GIS work that requires high-resolution data. Any users needing to utilize preprocessed data in offline applications can also take advantage of this easy-to-use application.

In addition to ESRI datasets, DataDoors for ArcGIS provides access to satellite data from various data providers, including DigitalGlobe, GeoEye, and Spot Image, as well as aerial imagery from aeroGRID and Microsoft, and Intermap's terrain archive. Multiple datasets can be retrieved in one order within a single AOI. A unified interface that ties together multiple vendors makes it easy to explore and compare the various data. While searching for content, specific scenes and thumbnails can be viewed, along with the metadata from search results.

DataDoors for ArcGIS is powered by i-cubed's DataDoors, a system designed to manage geospatial data assets. As the imagery aggregator for ArcGIS Online, i-cubed provides image processing and delivery services to ESRI.

More Information

For more information, visit **www.esri.com/datadoors**.

"Mapping for Everyone"—Three Simple Ways to Make Maps for Free

ESRI Brings GIS Power to the People with Mapping Web Site

ESRI has launched a Web site (**www.esri.com/mapping**) that allows anyone to create maps for free with simple GIS tools. Called Mapping for Everyone, the Web site includes tools that cover a range of mapping needs, such as embedding an interactive demographic map into a Web site, creating custom applications using Web Mapping APIs, and using a 2D/3D globe viewer on the desktop.

Mapping for Everyone contains the following mapping resources:

The Make a Map application on ESRI's new Mapping for Everyone Web site allows anyone to create a demographic map and embed it in their own Web page.

• **Make a Map—**The Make a Map feature includes a simple interactive Web map showing seven different U.S. demographic layers. Visitors can zoom in to an area of interest, select a demographic layer, then embed the map into their own Web pages simply by copying and pasting the automatically generated HTML.

• **Web Mapping APIs—**Visitors can access or download ArcGIS Web Mapping APIs to make their maps. Web Mapping APIs allow users to develop rich, interactive applications using JavaScript, Flex, and/or Silverlight. The page includes step-by-step instructions for installing the APIs, samples to help visitors get started, free map layers, and a gallery of live user sites where visitors can get ideas from applications other people have built. Web Mapping APIs are free for external noncommercial use.

• **Virtual Globe—**A third mapping option is ArcGIS Explorer, ESRI's free virtual globe viewer. Using ArcGIS Explorer, users can explore the world in 2D and 3D using both their own data and free available data from the ESRI Web site. In addition to the ArcGIS Explorer download, the virtual globe page gives visitors easy access to map layers that they can add to ArcGIS Explorer, such as topographic maps, shaded relief, and world transportation. Once visitors become familiar with ArcGIS Explorer, they can also visit this page to find free add-ins that extend the software's capabilities.

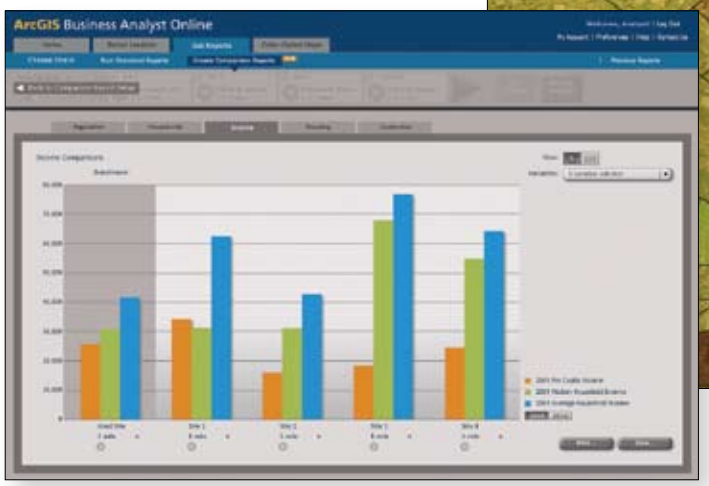
Mapping for Everyone includes a Community section where visitors can ask questions and collaborate with others. This section also provides access to ESRI's ArcGIS Explorer and Web Mapping API blogs.

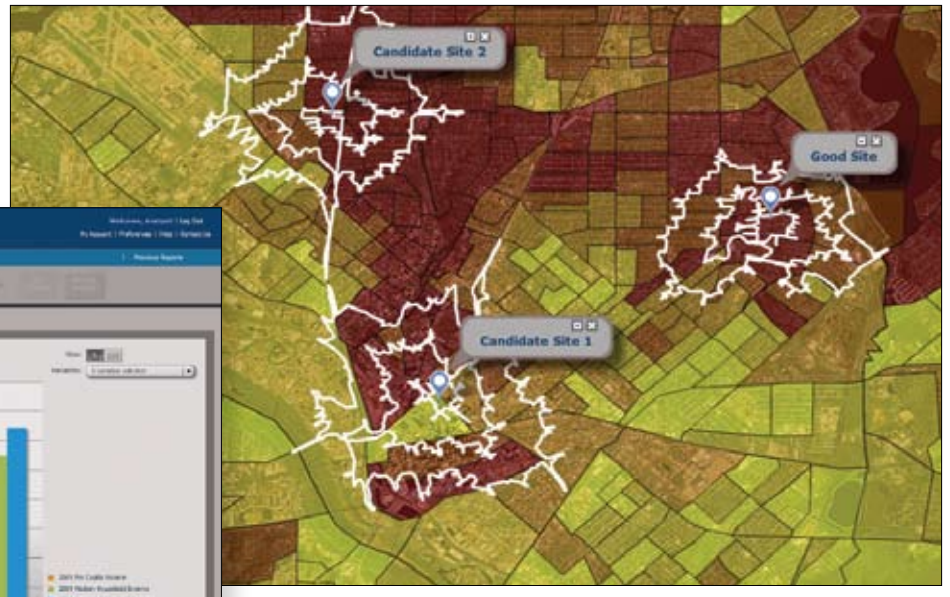
More Information

For more information, visit **www.esri.com/mapping**.

Compare Multiple Locations for Faster Decision Making

Custom Comparison Reports from ESRI Business Analyst Online





A visual comparison of proposed locations to a successful benchmark site.

Highlights

- Business Analyst Online helps users compare existing locations.
- Businesses can generate custom comparison reports using variables such as consumer spending.
- Location profitability can be compared to county, census tract, and national levels to check performance.

When businesses evaluate locations, they often compare sites to one another, or to a benchmark site that is known to be successful, to judge the suitability of the candidate locations. With ESRI Business Analyst Online, small businesses, retailers, real estate professionals, and many other business segments can now take advantage of new comparison reports. Through an easy-to-use wizard, businesses can choose demographic and consumer spending variables to create the custom reports they require. Many locations are geographically dispersed, sometimes over large distances. Managers and analysts in charge of site selection thus often do not have intimate knowledge of the individual parcels or surrounding locations and rely on Business Analyst to provide accurate, detailed data reports, which allow them to respond to competitive pressures quickly and efficiently.

Easily Create Robust Customized Comparison Reports

Organizations can now quickly access preformatted reports or create and save custom comparison reports with variables of their choosing that best meet their individual business needs.

For example, the recent economic downturn has led to numerous retailers closing store locations across the country. Business Analyst Online allows retailers to compare existing locations, not just in terms of same-store sales, but also with detailed analysis of the geographic region surrounding a particular store location. Combining factors such as local area population, daytime population, income, and competitors' locations, and viewing these in relation to their own customer and sales data, pinpoints the most viable locations and where there should be consolidation.

Economic developers use comparison reports to help attract new business to their cities. Benchmarking a prospective site to an already successful location highlights the demographic and geographic similarities between the sites. Economic developers can then use this analysis to show new businesses side-by-side data that can provide insights about the local labor force, population, and spending and lifestyle habits. Evaluating candidate sites in this manner reduces the time needed to compile and evaluate critical input factors when deciding whether to move ahead with a development or not.

Financial institutions are also using the new capabilities to compare their locations. By combining demographic characteristics provided by Business Analyst Online with individual site performance indicators, the characteristics common to successful sites can be easily identified. Business Analyst Online can then be used to find other suitable locations with similar characteristics.

Customized Level of Service

Thousands of companies and individuals have already integrated Business Analyst into their decision-making processes, making it an important business resource. The application is available in different subscription levels, from one-time-only reports to premium subscription packages and specialized development services. Nonsubscribers can purchase a day pass to take advantage of more than 50 preformatted reports and maps for 24 hours.

More Information

For more information about ESRI Business Analyst Online, visit **www.esri.com/bao**.

Imagery and Street Maps Enhanced

Updates, Expanded Map Coverage Highlight ArcGIS Data Appliance

The latest release of ArcGIS Data Appliance includes significantly enhanced map offerings. The imagery and street map data on the preconfigured network storage device have been updated, and coverage has been expanded to ensure that users have access to the most efficient and consistent data they need for their critical projects. ArcGIS Data Appliance, which powers ArcGIS Online, is used by many organizations that need reliable access to high-performance data and tasks behind their firewalls.

ESRI's imagery offerings have now been combined into one unique service on ArcGIS Data Appliance. All the previously available offerings, including World IKONOS Cities Imagery, World Imagery, and USA Prime Imagery, have been merged and blended, along with new high-resolution imagery for the United Kingdom, such as Getmapping, and other countries. The best data from each service was used to provide the optimal vintage, resolution, and coverage for the new imagery collection.

The updated imagery offering includes submeter coverage for the United Kingdom from Getmapping.

The World Street Map offering has been updated with improved cartography. The new better-looking maps now also include building footprints. The maps for North America and Europe have also been updated to 2009 data from Tele Atlas and AND Mapping. For Europe, the street map has expanded coverage for the largest-scale level (1:5,000 meters). International coverage has also been expanded to include detailed street maps for Colombia, Hong Kong, Japan, and Thailand.

All the maps available on ArcGIS Data Appliance have been migrated to a new tiling scheme in the latest release. They are now in the Web Mercator Projection, 256 x 256 pixel tiles with refined scales. This is the same tiling scheme used by Bing Maps and Google Maps, allowing users to more easily create mashups with other popular Web maps. All ESRI maps will soon be in the same projection, simplifying caching decisions for ArcGIS users.

As ArcGIS Data Appliance powers ArcGIS Online, all these updates and enhancements will also soon be available on the online map services.

More Information

For more information, visit **www.esri.com/dataappliance**.

Geodatabase Toolset for ArcCatalog 9.3.1 Now Available

The Geodatabase Toolset for ArcCatalog provides a collection of tools to assist in the monitoring, investigation, and reporting of the performance of multiuser geodatabases. It works with ArcGIS 9.3 and 9.3.1 multiuser geodatabases implemented on SQL Server, SQL Server Express, Oracle, Informix, DB2, and PostgreSQL databases.

The Geodatabase Toolset provides a wide variety of information, including

- The total number of rows in the add and delete tables of versioned datasets
- Users connected to the geodatabase
- A graphic representation of the relationships between versions in the geodatabase
- Detailed information of a feature class spatial index
- Table and index statistics for multiuser geodatabases implemented in Oracle

Geodatabase Toolset for ArcMap, which provides geodatabase investigation and reporting tools in ArcMap, is coming soon.

More Information

To download the Geodatabase Toolset for ArcCatalog, visit **www.esri.com/gdbt**.

Time Awareness in ArcGIS 9.4 Leads to Better Understanding of Complex Geographies

Visualizing Time in GIS

In his *First Law of Geography,* noted geographer and cartographer Waldo Tobler states, "Everything is related to everything else, but near things are more related than distant things."

GIS professionals are well versed in visualization of *spatial* relationships and dependencies, of the proximity of near things and distant things, as in things you can measure with a ruler or with mile markers. But often when studying geography and looking for relationships and dependencies, equally important is *proximity in time,* as in something that can be measured with a watch or calendar.

Pioneering environmental planner Ian McHarg is widely known in the GIS community as the "discoverer" of overlay theory, the base theory behind GIS. Another of McHarg's discoveries—perhaps lesser known, but equally important—is *chronology,* or the placing of geographic layers in chronological sequence to show relationships, dependencies, and causation through time. "We found the earliest events, mainly of geological history, had pervasive and influential effects, not only on physiography, soils, and vegetation, but also on the availability of resources," McHarg states, describing an environmental planning study in the 1960s, in *A Quest for Life*. He calls his discovery of chronology—the order or sequence of features through time—". . . a most revelatory instrument for understanding the environment, diagnosing, and prescribing," a construct that leads to a deeper understanding of structure and meaning in the landscape.

Chronology is enabled by temporal data. Temporal data is data that specifically refers to times or dates. Temporal data may refer to discrete events, such as lightning strikes; moving objects, such as trains; or repeated observations, such as counts from traffic sensors.

Depicting spatial change over time is a four-dimensional problem, and visualizing temporal phenomena on a two-dimensional map has always been a challenge. The simplest approach is the map series, where individual maps of geographic conditions at certain points in time are presented individually, in chronological order.

Other inventive methods of visualizing change over time and space include creative symbolization, such as in Charles Joseph Minard's famous map of Napoleon's march across Russia.

Temporal GIS is an emerging capability for integrating temporal data with location and attribute data, enabling temporal visualization and ultimately temporal analysis. Visualizing change on a computer screen in a GIS environment may give the viewer more options, but it is still a challenge. A simple yet highly effective method of visualizing time in GIS is through animation—displaying a series of maps in rapid succession on the screen.

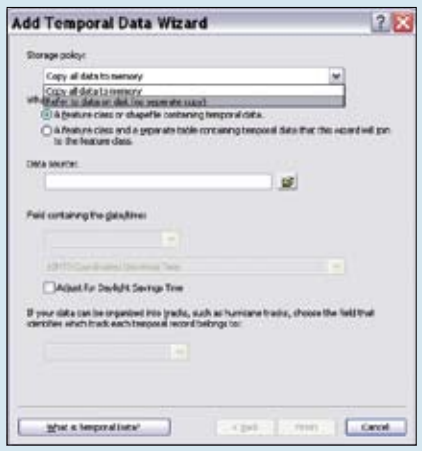
"The eye and brain are enormously efficient at detecting patterns and finding anomalies in maps and other visual displays," says Michael Goodchild of the University of California, Santa Barbara. "GIS works best when the computer and the brain combine forces and when GIS is used to augment human intuition by manipulating and displaying data in ways that reveal things that would otherwise be invisible." Building a robust temporal capability into GIS provides the human eye and brain with powerful visual tools to help determine the reasons why things happened in space-time. It is also key to modeling and predicting things that might happen in the future.

You can control visualization of temporal data in ArcGIS 9.4 using the new "time slider."

ArcGIS Tracking Analyst 9.4

The ArcGIS Tracking Analyst extension provides specific rendering and real-time processing for change detection or "tracking"-style analysis on vector data. ArcGIS Tracking Analyst is ideally suited for applications that require near real-time processing of high-volume, low-latency information and when near real-time intelligence needs to be applied through actions or specific tracking-style visualization.

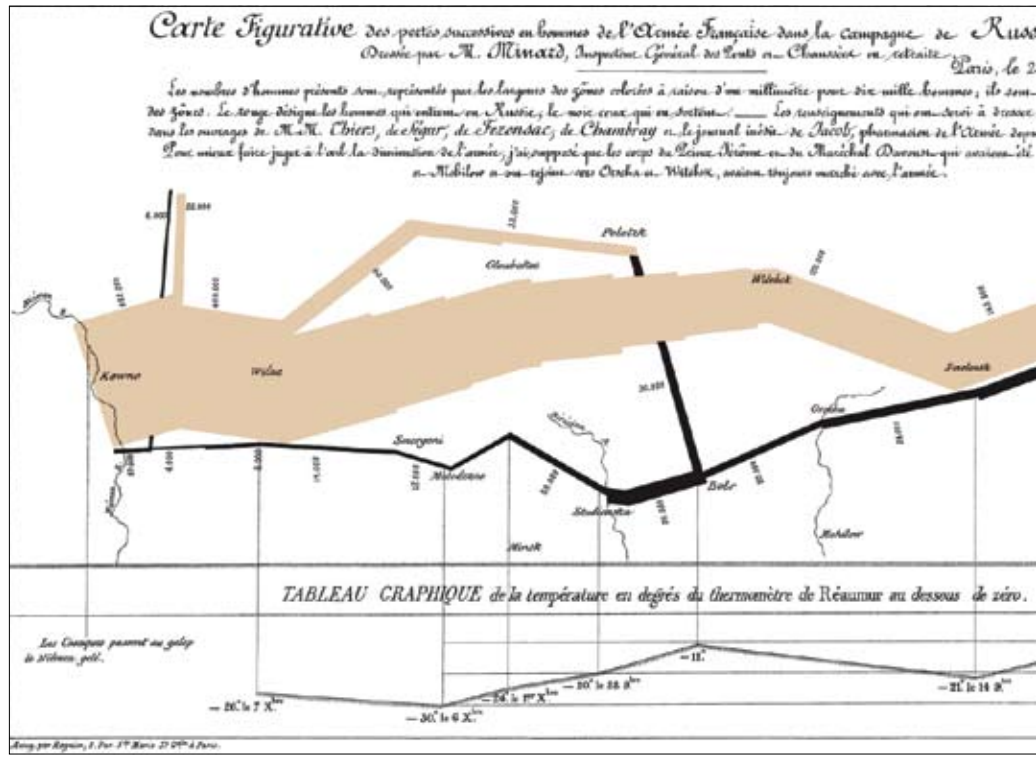
New ArcGIS Tracking Analyst features at the 9.4 release include



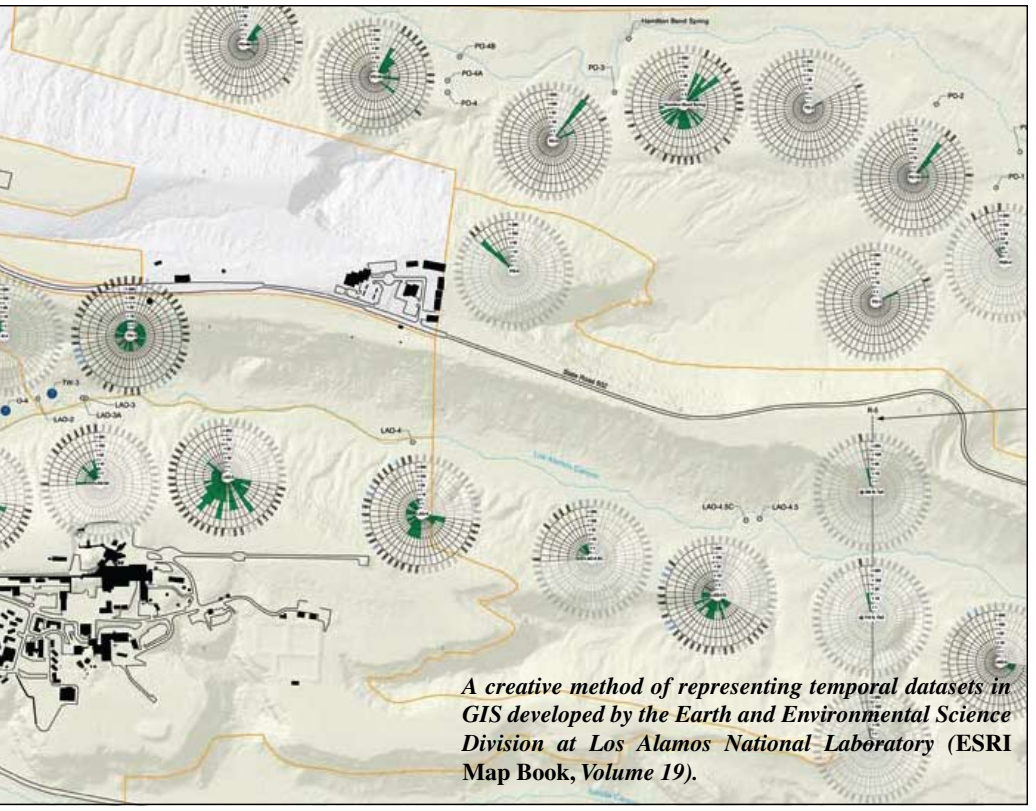
- A new storage mode that removes limitations on the size of available memory
- New action types, such as E-Mail Alert, Data Modification Service, and Data Summary Service actions
- New action triggers, including Arriving Trigger, Departing Trigger, and Track Crosses Trigger

More Information

For more information, visit **www.esri.com/trackinganalyst**.



Charles Joseph Minard's 1869 flow map of Napoleon's 1812 Russian campaign is a classic example of spatiotemporal visualization (Image Source: Wikimedia Commons).



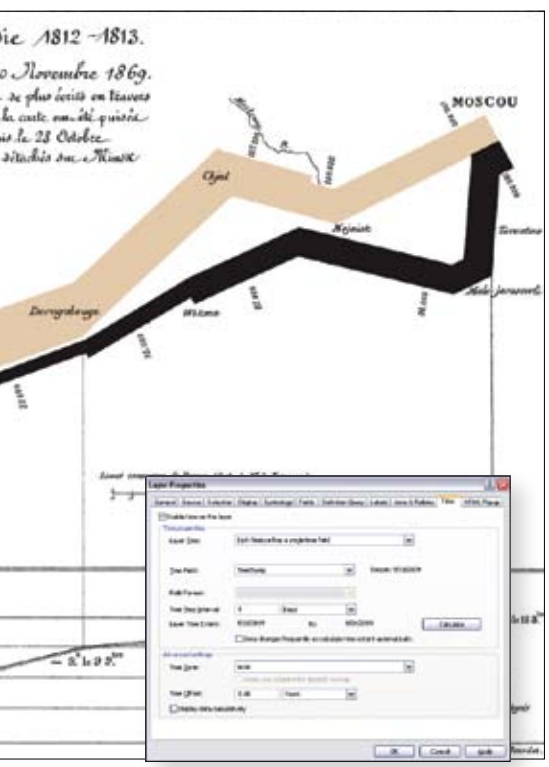
***A creative method of representing temporal datasets in GIS developed by the Earth and Environmental Science Division at Los Alamos National Laboratory* (ESRI Map Book, *Volume 19*).**

The new time-aware functionality in ArcGIS 9.4 lets you

- Create and manage time-based data.
- Display and animate temporal datasets.
- Publish and query temporal map services.

ArcGIS 9.4 makes temporal mapping simple and easy; enables temporal data management, exploration, and visualization; and creates a strong foundation upon which sophisticated temporal geoprocessing tools and workflows can be built in the future. As McHarg states in *To Heal the Earth,* "Processes, laws, and time reveal the present." And once we have the tools and techniques in place to fully grasp how the past has created the present, we can use these same tools and techniques to shape our future.

More Information
For more information, visit **www.esri.com/whatscoming**. AN



The user interface in ArcGIS 9.4 lets you set time properties for one or more layers.

Space-Time Modeling and Analysis Workshop

Scientists working on understanding the integration of space and time will gather in Redlands, California, February 22–23, 2010, to attend the Space-Time Modeling and Analysis Workshop. The workshop will be part of the first Redlands GIS Week—a gathering of thought leaders from academia, government, and industry to advance the science and application of geospatial technologies. The remainder of Redlands GIS Week 2010 will be dedicated to informal networking activities, demonstrations, and technical tours.

The Space-Time Modeling and Analysis Workshop will feature keynote presentations, lightning talks, and small group discussions, as well as opportunities for informal brainstorming with leading geospatial thinkers and implementers. Redlands GIS Week will be held at ESRI's headquarters, as well as nearby sites in Redlands, California. The event is cosponsored by the Association of American Geographers (AAG), the University of Redlands, the University of Southern California, and ESRI. After the workshop, a publication will share the event's results with a larger audience.

More Information
For more information and to view the call for participation, visit **www.redlandsgisweek.org**.

Redlands GIS Week

Monitoring the Albertine Rift in Africa

Custom Web GIS Functionality Facilitates Data Exchange

By Jared Stabach, Dan Deneau, and Greg Fiske

Highlights

- ArcGIS Server runs geoprocessing routines on the fly, such as extracting shapefiles and converting features to graphics.
- With ArcObjects, many custom tools and interfaces were built for the Web GIS.
- Data for five protected areas throughout Uganda is available within one access point.

Stretching from the northern end of Lake Albert to the southern end of Lake Tanganyika and spanning portions of Uganda, Rwanda, the Democratic Republic of Congo, Burundi, and Tanzania, the Albertine Rift is one of Africa's most important—and most threatened—sites for the conservation of biodiversity. Formed over the course of millions of years, the Albertine Rift is the result of two tectonic plates that collided and are now slowly pulling apart. This geologic activity has created some of the continent's tallest mountains and a number of the world's deepest lakes and contributed to the diversity of habitats that include active glaciers, alpine grasslands, volcanoes, lowland and montane forests, and various grass and woodland savannas.

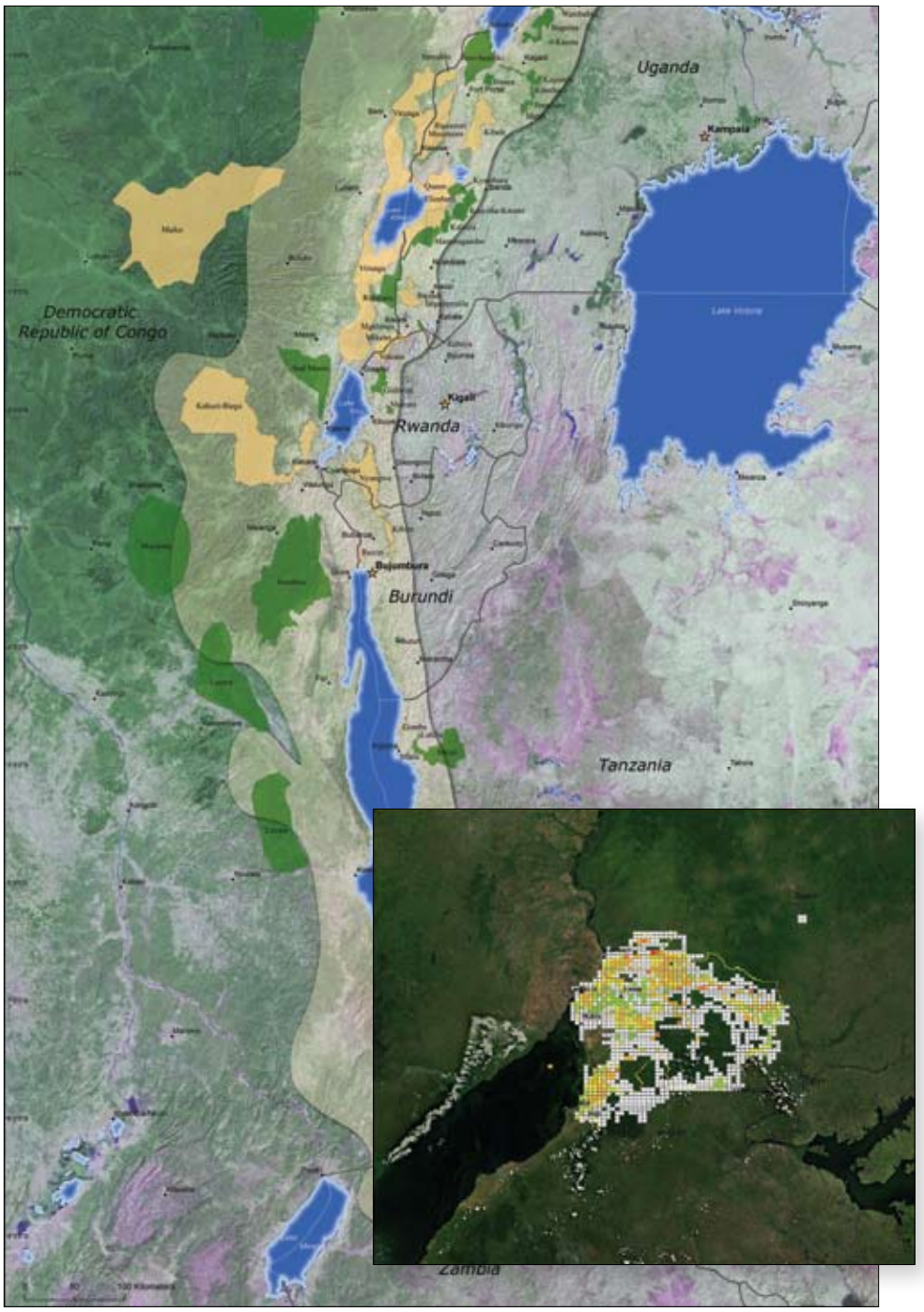
Since the early 1990s, however, this hot spot of biodiversity (home to more than 7,500 species of endemic plants and animals) has been plagued by a series of devastating conflicts, resulting in more than 3 million deaths and the displacement of approximately 2.7 million people. The region is one of the most populous in Africa, with up to 300 people per square kilometer in some locations. In addition to the pressures of population density, an influx of refugees and the lack of settlement policies have compounded the problem of forest degradation, fragmentation, and loss—particularly in protected areas.

The Need for Remote Sensing

Three years ago, the Woods Hole Research Center (WHRC) of Falmouth, Massachusetts, began working in the region to promote the development and use of remote sensing as a tool for conservation, with the principal goal to better facilitate the exchange of information between collaborative members of the conservation communities, such as the Wildlife Conservation Society (WCS) and the Uganda Wildlife Authority (UWA).

WHRC activities have included the integration of remote-sensing analysis into existing decision support systems (such as the Uganda Management Information System); the production of basemaps of land use/land cover, deforestation, and fire extent; and the development of monitoring tools that combine remote-sensing and biodiversity data.

The acquisition and exchange of this important conservation data, in turn, are intended to improve natural resource management, distribute spatial information to support conservation policy analysis, encourage a dialog across a broad user community, and provide technical training to support the long-term use of spatial data and analysis tools.



Map of the Albertine Rift region. Inset: Map showing density of Uganda Kob, a type of antelope, throughout Murchison Falls Conservation Area for the time period 1997–2004 and areas of high density throughout the savanna portions of the area. Data has been normalized to account for survey effort (distance walked within a 2 km grid cell). Image also highlights areas that have yet to be surveyed (no data).

Building a Web Interface

To better accomplish these goals, WHRC identified the need to provide data via a Web interface. While standard off-the-shelf Web GIS applications can easily be implemented, their generic interfaces lacked tools that were necessary to interact with both nontechnical and more technically inclined users (e.g., inability to access metadata information or to query raster datasets). Thus, WHRC teamed with the Institute for the Application of Geospatial Technology (IAGT) of Auburn, New York, which had experience building mapping applications, to develop a customized Web GIS application.

IAGT selected ArcGIS Server for the development of the Web GIS because the institute could take advantage of ESRI's ArcObjects. The ArcGIS Server platform allows users to do more than merely display and navigate the map. As users interact with the mapping application, ArcGIS Server runs geoprocessing routines on the fly, such as extracting shapefiles and converting features to graphics (and vice versa). Several custom tools were created to make the custom Web GIS application a more interactive and useful tool.

Data for five protected areas throughout Uganda (Budongo/Bugoma Forest Reserve, Kibale National Park, Murchison Falls Conservation Area, Queen Elizabeth National Park, and Semuliki National Park) is currently available within one access point. The data displayed is a culmination of various remote-sensing-derived products (e.g., land cover, base imagery) and vector information that was collected by UWA rangers. These vector layers include general spatial information related to each of the protected areas (e.g., protected area boundaries, rivers, roads), information related to the threats throughout the park (e.g., encroachment, poaching), and wildlife sightings that have been collected during UWA ranger patrols (1985–present, depending on the protected area).

About the Authors

Jared Stabach and Greg Fiske are research assistant/associates at the Woods Hole Research Center in Falmouth, Massachusetts. Dan Deneau is a software engineer for the Institute for the Application of Geospatial Technology at Cayuga Community College in Auburn, New York. IAGT specializes in geospatial application development and data processing.

More Information

For more information, contact Jared Stabach, research assistant, Woods Hole Research Center (e-mail: jstabach@whrc.org). This work is funded by the NASA Application Program—Ecological Forecasting—Biodiversity, with additional funds from the National Science Foundation Human and Social Dynamics program.

Restoring Angola's Electricity Network

Government Seeks 100 Percent Electrification in Urban Areas, 60 Percent in Adjoining Areas

Highlights

- Electricity planning moves forward with the updating of 20-year-old maps.
- Improved information leads to electricity service for more than 6,500 households.
- GIS improves transparency and stakeholder participation in municipal planning.

Angolans have suffered three decades of civil war, and only in recent years have they been able to begin the slow process of reclaiming their nation by rebuilding both the physical and social infrastructure necessary for peace, security, and economic growth. A critical component of this progress is the restoration of the electricity network. The government of Angola has set a goal to provide 100 percent electrification in urban areas and 60 percent electrification in adjoining areas by 2012. The U.S. Agency for International Development (USAID) is assisting Angola's government in reaching this target. A pilot project is under way to address the electrification goals, piloting innovative methods to improve electrification in the adjoining areas.

To address this need, the Academy for Educational Development (AED), a leading nonprofit organization working globally to improve education, health, civil society, and economic development, is working with Empresa Distribuidor de Electricidade (EDEL), Angola's national electricity distribution company, and two municipal governments to provide training in urban planning, engineering, and capacity building through the USAID-funded Angola Electricity Support Program (AESP).

Closing Information Gaps

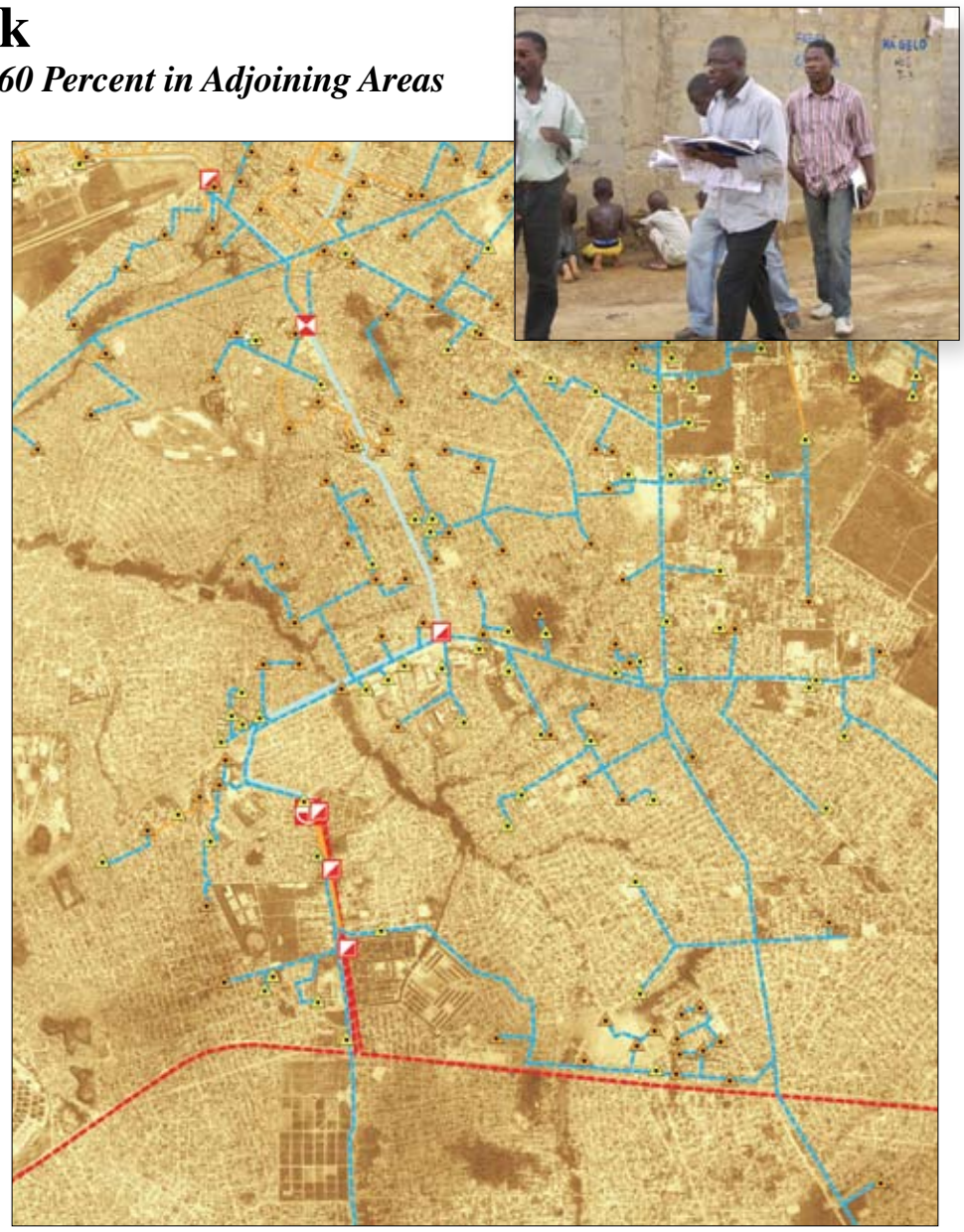
Up-to-date maps are essential for planning and managing municipal infrastructure. Cadastral maps are critical for granting land titles and acquiring data necessary to establish an electricity connection. Prior to the launch of AESP, the most recent cadastral maps available in Angola dated back to 1989, a serious barrier to the design and implementation of electricity access programs.

"Providing electricity to homes and businesses requires more than just installing poles and stringing cable," says Joao Baptista Borges, the chief executive officer of EDEL, which provides service to more than 7 million people in and around Luanda. "Maps, census, customer, and infrastructure data—which are outdated or nonexistent in Angola—are fundamental in planning for and providing electricity."

One of the first activities under AESP was the systematic gathering of information about community resources, households, and infrastructure already in place in the pilot areas. AESP employed ArcView software to introduce its Angolan counterparts to GIS in order to develop accurate baseline information on residences and businesses in the municipalities of Kilamba Kiaxi and Viana. The information collected through surveys and site visits was added to geographic data and maps to create the most up-to-date geographic information systems for the two municipalities.

AED selected ArcView based on ESRI's reputation and because the software is easy to use for inputting and manipulating data for utility, governmental, and community use.

The newly created maps contain information on land plots and existing electric networks and



Electricity network in the municipality of Kilamba Kiaxi, Luanda, created in GIS. Inset: Surveyors in Kilamba Kiaxi map the municipality.

are providing EDEL with vital information, such as street addresses, meter numbers, and where houses are connected to the electrical system. That information will help EDEL deliver more accurate electricity bills, provide better customer service, and extend the network.

A further breakdown of the layered datasets provides information detailing the extent of electrical infrastructure. With this information, AED and local stakeholders were able to gather and analyze trend information and establish a concrete understanding of who was benefiting from electricity, differentiating between legal and illegal connections and identifying which households were not electrified.

A Sustainable Intervention

In addition to upgrading the quality and type of information available, there is a capacity-building component to AESP. To date, EDEL and municipal government staff have been trained on the use and application of ArcView software and GIS principles. The training was so successful—and the software so useful—that EDEL has secured its own ArcView software licenses.

As this project continues, training has been expanded to local stakeholders, including small businesses, civil servants, and residents. Within a forum of open dialog and transparency, municipal governments will have increased opportunities for iterative planning, flexibility, and adjustment. This will lead not only to improved electrical infrastructure but also to increased capacity through collective engagement, planning, and improved governance practices.

Community members in the AESP pilot areas place a high value on the information that has become available to them through the application of GIS. Equipped with information, community groups and individual households are better able to communicate their needs to EDEL and advocate improved service.

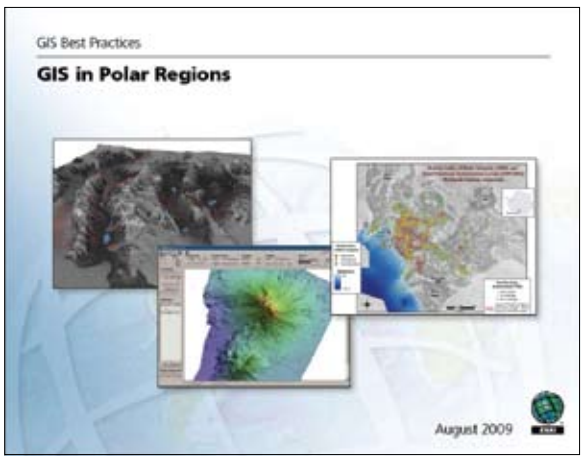
GIS has forged new paths and shed new light on underutilized power sources, forecasting, and long-term capital planning. AESP has increased access to electricity or improved electricity service for more than 6,500 households. Another 25,000 households will be supplied with electricity in 2009.

More Information

To learn more about the Angola Electricity Support Program, contact Mary Worzala, director of energy programs, AED (tel.: 202-884-8034, e-mail: mworzala@aed.org).

Free E-book

GIS in Polar Regions



ESRI is pleased to make available *GIS in Polar Regions,* an easy-to-access, no-cost booklet featuring *ArcNews* articles showing science at work in the arctic and antarctic regions of our planet.

Begun three years ago, ESRI's Best Practices series now contains more than 30 e-books that cover a wide range of topics in GIS, such as science, retail business, law enforcement, and air quality. These e-books are instantly available online at no cost. Published as PDFs with color illustrations, these e-books can be read online at the ESRI Web site or downloaded and printed. Additional titles will become available frequently.

See Complete List
For a complete list of GIS Best Practices e-books currently available, visit www.esri.com/bestpractices.

Exclusive *ArcNews* Articles Online

The Winter 2009 issue of *ArcNews* Online (www.esri.com/arcnews) presents the following exclusively online articles:

The Mission of Coordinating Safety
From the aftermath of Gustav and previous hurricanes, the Louisiana National Guard learned that future responses needed a more efficient method for processing vast quantities of imagery. The state developed a GIS that would assist with its missions at federal, state, and local levels.

Vegetation Management Goes Mobile
The Vermont Electric Power Company's 688 miles of high-voltage electric transmission lines and 12,000 acres of rights-of-way share space with a wide and colorful variety of plant life. The company developed a vegetation management system for the utility based on GIS technology.

Enterprise GIS Connects Utility's Many Divisions
As Colombia's largest public service company, Empresas Públicas de Medellín provides the area with water, natural gas, subscription television, wastewater treatment, and telecommunications services. With ArcGIS, the company designed and is now implementing an enterprise GIS.

Also, look for the expanded ESRI T-shirt section online, as well as new supplemental podcasts.

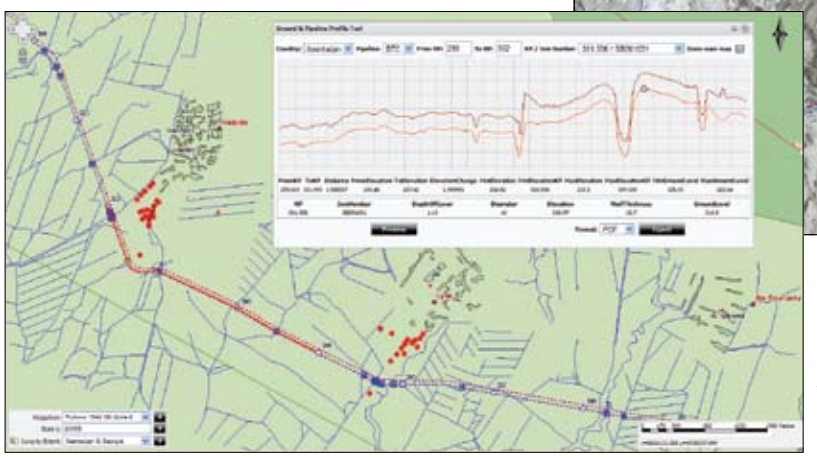
Revisiting "Students Scale New Heights"

Correction—The map of the Ladakh region of the Himalayas that was printed on page 17 of the Summer 2009 *ArcNews* did not include credit. Credit should have been assigned to Dr. Abram Pointet, independent Ladakh cartographer, and to the publishers, Olizane Editions of Geneva, Switzerland. To view the publisher's information about the map, please visit www.olizane.ch/article.php?IDrecord=213. ESRI sincerely regrets any confusion or inconvenience this error may have caused.

BP Azerbaijan Manages World-Class Pipeline with GIS

Highlights

- ArcGIS Server provides secure, focused user access to hundreds of data layers.
- Engineers now have a hands-on swipe tool that helps identify changes.
- ArcGIS Server helped BP Azerbaijan minimize custom code.



Left: Every weld in the 1,768-kilometer-long Baku-Tbilisi-Ceyhan pipeline is registered in BP Azerbaijan's GIS. The easiest way for a pipeline engineer to locate a weld is by using its x,y,z coordinates. Above: BP Azerbaijan operates four pipelines that transport crude oil from the Caspian Sea to the Mediterranean and Black seas. Pipeline engineers use satellite imagery to help monitor changes to the landscape over time.

Currently celebrating its 100th year of operations, British Petroleum (BP) is one of the largest energy companies in the world, employing 92,000 people in more than 100 countries across six continents. BP's primary operations involve finding, extracting, and transporting oil and gas to create a variety of consumer products, such as gasoline and home heating oil.

One of those countries is Azerbaijan. Nestled east of Turkey, south of Georgia, north of Iran, and west of the landlocked Caspian Sea, Azerbaijan straddles the border between eastern Europe and Eurasia. Though it is a relatively small nation, its extensive and strategically located oil reserves led BP to quickly establish operations in Azerbaijan following the dissolution of the Soviet Union in the early 1990s.

With production levels at 3.8 million barrels of oil per day, BP Azerbaijan relies on pipelines and a fleet of tankers to transport the oil worldwide. Given its landlocked geography, BP Azerbaijan makes extensive use of pipelines and manages four of them, including the Baku-Tbilisi-Ceyhan (BTC) pipeline.

After years of route planning and construction to address political, geographic, and environmental considerations associated with opening the flow of Caspian region oil to western markets, the BTC pipeline began moving crude oil in 2005. Spanning 1,099 miles (1,768 km) of often challenging terrain—including several mountain ranges and 1,500 watercourses—the BTC pipeline is the second longest in the world. Bypassing the congested sea-lanes of the Bosphorus Strait, it transports over a million barrels of crude oil per day from a marine terminal near Azerbaijan's capital city of Baku, through Georgia, to the Mediterranean coast of Turkey, where it is transferred to tankers for shipping to Europe.

Historical Perspective

To help manage the complex planning and construction of the BTC pipeline, the GIS team of BP Azerbaijan used both an internal ArcGIS Desktop application and an external, Web-based ArcIMS application for sharing data with the engineers responsible for routing the pipeline. This publicly accessible Web mapping application also supported external agencies responsible for making complex and important decisions concerning land management, transportation, and environmental assessment.

"As the project progressed, we started identifying newer and more powerful uses for GIS," explains GIS team leader Emin Hamidov. For example, the GIS team used polygons on the pipeline's map to represent the progress of each of the nine steps involved in laying pipe: grading, trenching, pipe stringing, welding, nondestructive testing, joint coating, lowering, backfilling, and reinstatement. Working concurrently on different steps kept the work on schedule, but all effort had to be carefully balanced against sequencing constraints, like the safety standards that limited the length of trench that could be dug before the previous section was backfilled. By updating the polygons daily with the data coming in from the field, the team members were able to see the point to which each step had been completed. From this, they determined how to optimize progress and prevent equipment from sitting idle.

By the time oil started flowing through the pipeline in 2005, the GIS team members were already contemplating how to refocus their Web-based GIS efforts to meet changing stakeholder requirements. While the existing ArcIMS system was designed to manage pipeline planning and construction, the team's custom applications had never been intended to provide the functionality BP Azerbaijan needed for managing operations on an ongoing basis once pipeline construction had been completed.

Full-Powered GIS via the Web

For example, one feature the team was keen to introduce to the Web was a pipeline profile tool that would show the depth of ground cover along the full length of the pipeline. "If you need to do some excavation work, this is very important," explains Hamidov. "It's one thing to click on a point to see the data and quite another to look at the profile. You can very quickly see where the thin bits are."

Another feature Hamidov and his team desired was a swipe tool that could be used to slide a layer aside. "Every year we order satellite imagery. The swipe tool is a hands-on tool for the engineers that helps identify changes. You can swipe one image on top of another and quickly pick up the changes in a particular area," he says.

Rather than reengineer BP Azerbaijan's existing ArcIMS Web GIS application, it appeared sensible to leverage ESRI's new ArcGIS Server technology to meet its next-generation requirements; ArcIMS had been an excellent mapping engine, but ArcGIS Server provides access to the full power of ESRI GIS via the Web.

A core aspect of BP Azerbaijan's strategy for the future was to minimize custom code while ensuring a solution that would evolve over time with core ESRI technology. The GIS team also believed that an off-the-shelf solution used in conjunction with ArcGIS Server was key to ensuring the new system's extensibility and longevity in a way that no custom solution could. The search for solutions that provided additional out-of-the-box functionality for ArcGIS Server led the team to Geocortex Essentials, an add-on product developed by ESRI Business Partner Latitude Geographics Group Ltd. of Victoria, British Columbia, Canada, to deliver extensive features and development options for ArcGIS Server.

Although Geocortex Essentials offered much of the required functionality out of the box, BP Azerbaijan sought a number of supplemental features to be incorporated into the core product. This shifted the long-term responsibility for maintaining such features to Latitude Geographics and prevented the support challenges BP Azerbaijan had faced with custom-coded features built for its previous system. "By the time the project was complete," observes Hamidov, "we had about 95 percent of the functions we required through core Geocortex Essentials. This was very important to us."

Seven new applications powered by ArcGIS Server, deployed by BP Azerbaijan, provide secure, targeted user access to hundreds of data layers that assist informed decision making. In addition to Web-based pipeline profiling tools and layer swipe tools that provide enhanced visualization, the applications also offer custom map reference grids for large-format, template-based printing; reprojection of map data according to custom projections; uploadable and linked images to the map; and the performance of specialized coordinate-based map requests. Taken together, such features have extended BP Azerbaijan's ability to couple the power of GIS with everyday workflows for nonspecialist users.

To support the ArcGIS Server implementation, the GIS team also uses Geocortex Optimizer, another add-on product developed by Latitude Geographics, designed to track site usage, improve application usability, and support the creation of monthly management reports to empirically demonstrate systemwide return on investment.

With the production system well received by users, BP Azerbaijan project manager Govsiya Maniyeva notes, "The outcome of this project has been a system that provides not only what BP Azerbaijan needs now but also the technology foundation to meet the long-term requirements of our organization."

More Information

For more information, contact Govsiya Maniyeva, project manager, BP Azerbaijan (e-mail: maniyegr@bp.com), or Tom Kasmer, project manager, Latitude Geographics (tkasmer@latitudegeo.com).

Piecing Together the Data Puzzle

Eugene, Oregon, Police Department Uses GIS to Make Sense of Its Data

Highlights

- ArcGIS integrates multiple information systems.
- Visualization helps officers understand complex data.
- GIS provides a common operating picture for event security.

The Eugene, Oregon, Police Department (EPD) is a progressive crime-fighting agency. The organization combines old-fashioned policing with a high-tech philosophy to best serve its more than 140,000 residents. In a typical day, Eugene police officers are dispatched to roughly 300 calls for service, and 25,000 criminal cases are handled annually.

EPD staff members also engage in proactive community education and crime prevention activities, with offerings ranging from an annual Safety Town program for prekindergartners to seminars about recognizing and preventing elder abuse. To improve the quality of these and other ongoing programs, the department uses GIS to link the torrents of data that are now part and parcel of a modern, urban police force.

Data capture now includes records management data, computer-aided dispatch data, situational awareness reports, incident accounts, accident descriptions, traffic violations, code infractions, calls for service, and information from other sources. These are all now made available for analysis through one coherent, easily shared information resource. Commanders make long-term strategic decisions using high-level spatial analysis, front-line officers use mapped data for better decisions in the field, and a public Web site helps the agency keep its citizens informed of crime rates in their neighborhoods.

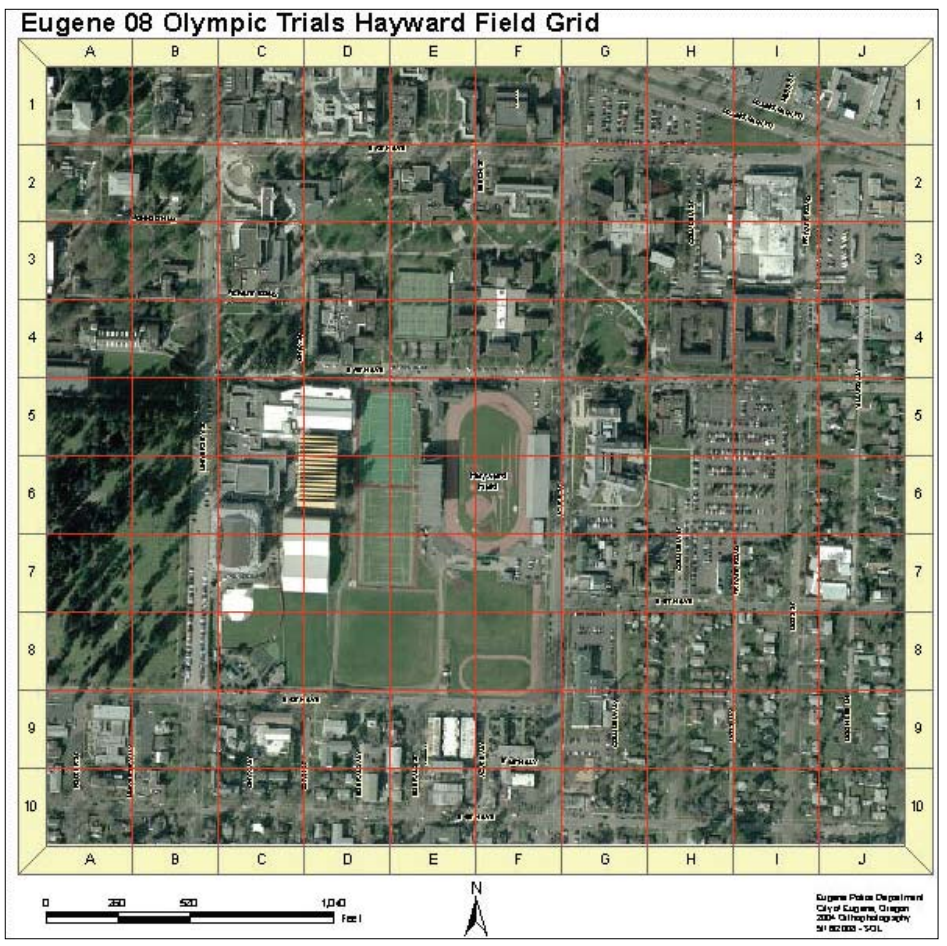
One of the department's greatest GIS successes involved the use of spatial analysis and high-powered visualization for providing security during the 2008 U.S. Olympic Team Trials for track and field, which Eugene hosted from June 27 to July 6. GIS helped the department plan policing duties, effectively place equipment and security resources, and monitor events on the ground. By generating a map-based common operating picture, staff could effectively monitor events and dynamically respond to changing conditions on the fly.

Industry-Specific Software

"Originally, the agency acquired a software product for simple pin mapping," says Stan Lenhart, crime analyst, Eugene Police Department. "I came on board as a crime analyst and brought in a more powerful, industry-specific GIS application with tools to do better analysis." Jumping from simple desktop pin mapping to a more powerful desktop and Web GIS has resulted in more arrests and safer streets.

Specifically, following Lenhart's recommendation, the agency deployed CrimeView, a GIS desktop solution from ESRI Business Partner The Omega Group, based in San Diego, California. This ArcGIS software-based solution supplies an advanced interface to CAD and records management system databases. EPD uses CrimeView to perform sophisticated spatial computing operations: assist with data management and mapping, perform queries, generate reports, carry out analysis, and create maps.

"We use GIS now for long-term planning and daily operations," Lenhart says. "It also really paid dividends for the Olympic Trials. It won't make decisions for you. That's what I get paid to do. But it helps us deliver more accurate information faster to all of our officers."



This grid map was created to help orient law enforcement staff members from outside agencies to Hayward Field and the Eugene 2008 Festival venue.

Unlocking Crime Data

Over time, law enforcement has become a data-intensive industry. Each data point requires records that are brought into a database. These databases were once stored separately. Getting the most out of the ever-growing, isolated repositories used to be complex and daunting.

Now, however, officers can query data by attribute, geographic boundary, or proximity to a location or specified landmark. They can build density maps, such as clustering residential burglaries, to see where to best allocate officers to respond to crime. Hot spot maps help depict areas of high, moderate, and low crime rates. For instance, data from the records management system can be extracted and mapped to show excessive concentrations of assaults for a four-week time period. Maps are also generated showing repeat calls. If an address has a particularly high rate of calls, officers can use a map interface to click the address icon and view a data table showing the number of recent calls and their related data, such as incident type, responding officer, resulting action, and date and time of the call.

Lenhart also uses GIS tools to develop crime reports presented during monthly CrimeStat meetings. Spatial trend maps compare changes in crime patterns via a map view over specified time periods—for instance, robberies between two successive years. This gives commanders a macro-level understanding of crime trends. They can then better determine exactly where and how to respond to existing conditions on the ground.

Securing the U.S. Olympic Trials

The University of Oregon, located in Eugene, was host to the 2008 U.S. Olympic Team Trials for track and field. Attendees from across the country descended on the college grounds—renowned for top-notch sporting facilities—to witness athletes compete in events ranging from sprinting to the javelin throw that were the culmination of years of hard work. Held at the university's Hayward Athletic Field, the 10-day event attracted more than 165,000 people, making it the third highest in attendance for U.S. track and field Olympic trials.

The trials required comprehensive security. Providing safety for athletes, coaches, and Olympic judges and officials, as well as thousands of attendees, is no simple task. It involves properly assessing potential risks; understanding assets on the ground, including buildings, transportation corridors, housing, and street infrastructure; and planning for numerous contingencies, from simple car accidents, arrests, and medical emergencies to potential large-scale natural hazards or terrorist strikes.

"We spent the better part of a year working on a lot of different security issues," explains Lenhart. "Our GIS helped bring in data from multiple sources and view it using one comprehensive system. One of the issues that we had was that we had so many different law enforcement agencies from outside the area coming in to assist us that were unfamiliar with this area. We were able to build some aerial maps with a lot of landmarks so that they could get familiar with the areas they would be working." ArcGIS was used to build a grid system so that the agency could assign people to sectors and ensure the entire grounds were covered.

A central emergency command center was staffed by analysts; commanders; and representatives from local, state, and federal agencies. Participating agencies included the Bureau of Alcohol, Tobacco, Firearms and Explosives; Eugene Police Department; Federal Bureau of Investigation; Oregon Department of Justice; Oregon National Guard; and University of Oregon campus security.

A large 10- by 10-foot digital map projection was displayed on one of the center's walls. Staff could pan and zoom and move around the digital map display to see different areas of the event. Recently captured aerial photography, oblique imagery, and digital map layers showing buildings, electric facilities, roads, parcels, district boundaries, underground tunnels, athletic staging areas, security staff locations, emergency medical services locations, and other data, were all available to be viewed as needed.

A security perimeter was generated, along with separate entry points for attendees and athletes. Bus routes and drop locations were also calculated to be in close proximity to entrance locations, providing safety and security while at the same time ensuring the fastest possible entrance into the sporting event.

In addition, video cameras provided a real-time view of events. If personnel moved from one area of the athletic grounds to another, they could be seen by camera and recorded as a point on the map. The command center also had GIS map layers showing where vendors were allowed to operate.

Prior to the actual trials, staff used oblique imagery managed in ArcGIS to view buildings in such a way as to determine where to properly place cameras. They could look at a particular camera location to see if it would be unobstructed or if it would be hindered by another building wall or some other object, like trees or foliage.

During the trials, data was updated in the geodatabase and reflected in the common operating map. For instance, if an arrest or emergency incident occurred, it could be instantly annotated on the map. Data was used to respond to specific events, as well as to catalog everything that was happening, in near real time.

"At any given moment, incident commanders could see what was happening on the ground," says Lenhart. "If an incident was occurring, they could bring a response team into the Emergency Operations Center in front of that map and say, 'We've got this going on here. We need Oregon Department of Transportation to go over and put a roadblock at this intersection here.'"

ArcGIS was also used to generate action reports and maps for daily morning briefings, which Lenhart provided to field staffers and commanders' staff so they were aware of the previous day's activities.

The year of preplanning and on-scene due diligence paid powerful dividends. The event was a smoothly run operation, with no major incidents or emergencies. This is especially important as Eugene prepares for hosting the trials again in 2012.

"You have to educate your planners about the tools, their availability, and what they can do," emphasizes Lenhart. "Make sure that you include GIS early on as an integral part of the planning process. It can help in all phases of planning, making updates, sharing information, and working more effectively in a coordinated manner."

More Information

For more information, contact Stan Lenhart, crime analyst, City of Eugene Police Department (e-mail: stan.o.lenhart@ci.eugene.or.us, tel.: 541-682-5163), or The Omega Group (e-mail: omega@theomegagroup.com, tel.: 800-228-1059, Web: **www.theomegagroup.com**).

Upgrading a City's Land Base

Jacksonville Beach Uses ArcGIS Survey Analyst

By William C. Mann, AICP, City of Jacksonville Beach

Highlights

- ArcGIS Survey Analyst improves property line and right-of-way information.
- With GPS benchmarks and control points collected in the field, the team improved existing parcel information.
- Land-base enhancements have led to improved planning and public safety services.

Inaccurate documentation of property boundaries poses many problems for local governments in the United States. Spatial inaccuracies within a land base can lead to the inadvertent placing of utilities or other publicly owned facilities on private property when originally intended for placement in a right-of-way. Moreover, erroneous parcel information can often lead to disputes over property lines.

The City of Jacksonville Beach in northeast Florida experienced some of these problems because of significant spatial and attribute inaccuracies in its land base. Large numbers of parcel boundaries and right-of-way lines did not correspond to their known dimensions or locations, preventing the city from providing a variety of public services with a high level of confidence and precision.

"Without accurate parcel and right-of-way information, the city couldn't move forward with its infrastructure projects on a timely basis," says Donald F. Terrell, senior network administrator for the City of Jacksonville Beach's Information Technology Division. "A more precise land base would allow us to leverage this information among multiple city departments and introduce new applications and improved services."

Going Beyond the Typical

Typically, local governments have tried reconciling boundary lines using enhanced aerial photography, or orthophotography, and other planimetric data to visually place the location of parcels. But the city knew that its particular needs required going beyond this method. In an attempt to develop an accurate land base and public support, the city began exploring its options.

As it happened, staff at the local City of Jacksonville office of the facilities and infrastructure consulting firm of Reynolds, Smith and Hills, Inc. (RS&H), had another idea for the city. The firm proposed that the city improve its land base using the tools in ArcGIS Desktop software with its ArcGIS Survey Analyst extension, which features the Cadastral Editor workflow.

Cadastral Editor allowed the city and RS&H to create a topologically integrated geodatabase, or cadastral fabric, made up of lines, line points, points, and polygons that represent each parcel layer. Once the existing parcel data was integrated into the cadastral fabric, new fields containing the dimensions of each parcel segment were generated by the software. These dimensions were then compared with known dimensions collected in the field and corrected using Cadastral Editor's coordinate geometry (COGO)-based data entry capabilities.

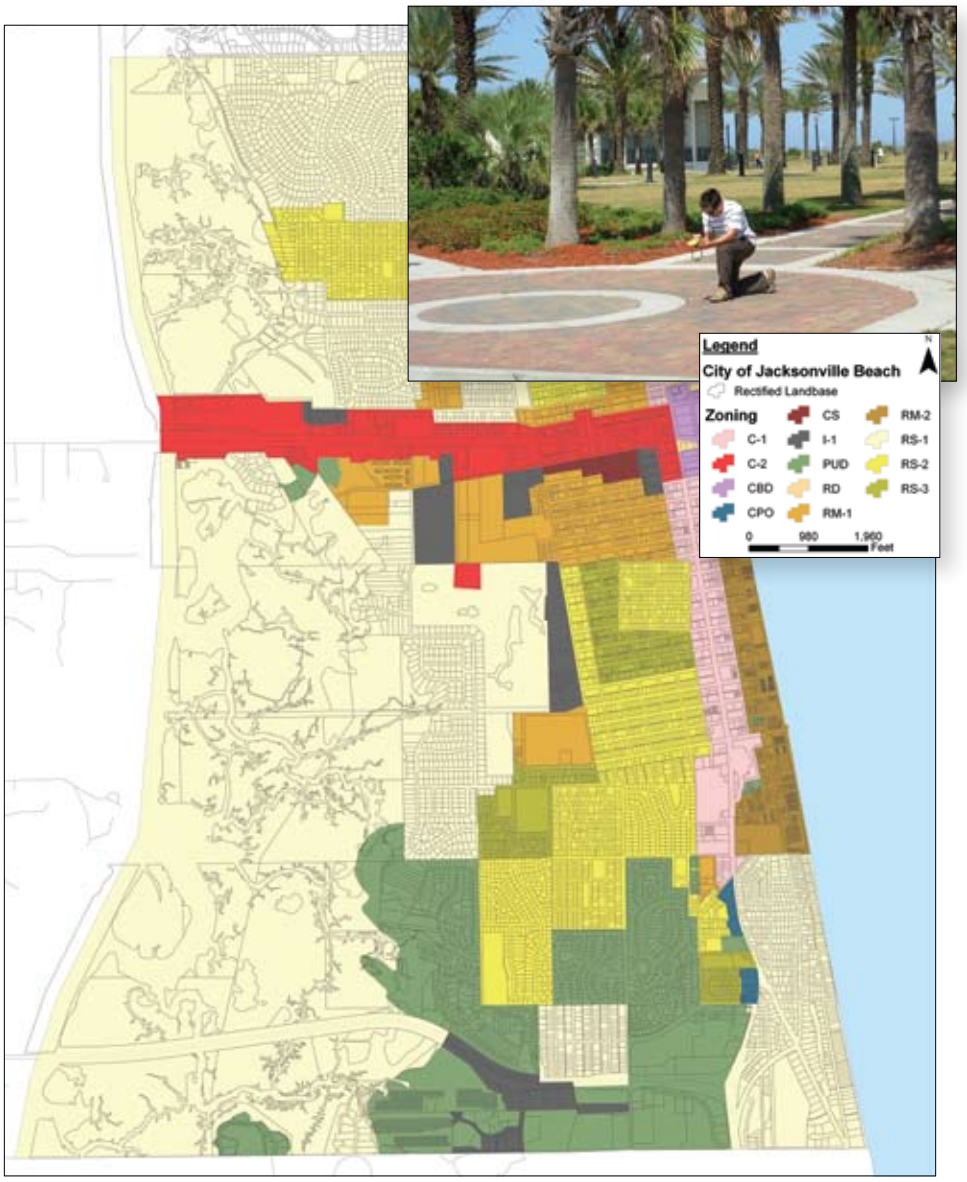
Data Cleanup and Field Collection

Prior to building the cadastral fabric, the team first performed a massive cleanup effort on the existing parcel data. The most common data issues involved pseudo nodes, overshoots, undershoots, and densified arcs:

- Pseudo nodes are arbitrary nodes located along the parcel vertex, which split parcel lines into multiple segments. Without correcting pseudo nodes, the dimensions would be split between segments, causing multidirectional distortions in the parcel shapes.
- Undershoots occur when the parcel line is too short, leaving a gap.
- Overshoots occur when the parcel line is too long, leaving a dangling node.
- Densified arcs are a sequence of many straight lines that are connected to make a curve.

These issues might have become a major concern when building the polygon layer of the cadastral fabric, since the Cadastral Editor does not create polygons unless parcel line segments are all connected at nodes, and the fabric only supports true arcs. However, RS&H sidestepped all these issues by acquiring one of ESRI's developer samples, the CurveConversion Command, which converts densified arcs into the required true arcs.

Concurrently with the data cleanup effort, the team also collected GPS benchmarks, monuments, and known locations of points—such as manholes, fire hydrants, and light poles—from high-resolution aerial photography provided by the city. Using this information, the team created a 14-section grid, dividing the project at major roadways. The team collected points using a Trimble GeoXH GPS unit coupled with a Zephyr antenna, providing submeter horizontal accuracy. These points were then postprocessed prior to incorporating them into the fabric to ensure subfoot horizontal accuracy.



A new and accurate zoning layer resulted from the updated land base. Top right: Fieldwork for Jacksonville Beach's land-base upgrade included collecting GPS points.

Parcel Rectification

The team began parcel rectification once the clean data and control points were built into the cadastral fabric. With nearly 15,000 parcels to rectify, RS&H designed a workflow that maintained the 14 grid sections and created a separate fabric for each one. This step streamlined the quality control and assurance process.

At the project's onset, the team set a five-foot tolerance on the parcels and identified three status categories: in-progress, review, and historical. In-progress parcels were those that still needed to be edited, while review parcels were those that had been edited but did not fall within the five-foot tolerance or were missing dimensions. The historical parcels were edited and within the five-foot tolerance. The initial analysis of the data involved identifying parcels that exhibited the correct dimensions and marking them as historical. Parcels in the review category were plotted on an aerial background and given to the city for final approval or direction for further correction.

While rectifying the parcels, the team used high-resolution aerial photography as the base layer to ensure proper placement of city blocks after they were disconnected and edited. It was extremely important to maintain and correct right-of-way information when reconnecting the parcel blocks. The accuracy of parcel corner points and dimensions was maintained within five feet.

A Proven Success

The City of Jacksonville Beach's land-base upgrade using ArcGIS Desktop software with its ArcGIS Survey Analyst extension is now benefiting the city's public safety and planning initiatives in a variety of ways. The police department is now using the new information to create more accurate maps for its emergency dispatch units and computerized enhanced 911 emergency services system. These improvements are possible due to the more accurate right-of-way dataset, which allows the creation of a more precise street centerline shapefile used in the geocoding process. In addition, the improved land base is being used by the city's planning and development, public works, and electric departments to make better decisions regarding the location and placement of utilities, as well as to better manage the city's assets.

About the Author

William C. Mann, AICP, is the senior planner for the City of Jacksonville Beach, Florida (www.jacksonvillebeach.org), and has over 24 years of community and facilities planning experience in both the public and private sectors.

More Information

For more information, contact William C. Mann, senior planner, City of Jacksonville Beach, Florida (e-mail: planning@jaxbchfl.net, tel.: 904-247-6231), or Kristy Capobianco, consultant for Reynolds, Smith and Hills, Inc. (e-mail: kristy.capobianco@navy.mil).

ArcGIS Server Disseminates City Geospatial Services

ESRI's ArcGIS Server adds geographic data and analysis to Web applications that serve organizations and communities in a variety of ways. To submit your ArcGIS Server site address and view other Web sites powered by ArcGIS Server, visit **www.esri.com/serversites**.

City of Miami, Florida
www.miami-sites.com
This site provides available commercial property search and market analysis capabilities to businesses, site selectors, and commercial real estate brokers. Developed by ESRI Business Partner MSF Global Solutions, LLC, this site uses the ESRI Business Analyst Online API and demographic data, ESRI's ArcGIS Server, and Flex to deliver an interactive solution to support location decisions within the City of Miami.

City of Provo, Utah
electionmap.provo.org
This online mapping application provides real-time interactive election results for the City of Provo, including voting breakdown (by precinct) via graphic ToolTips, a dynamic bar graph demonstrating race leaders and total votes by candidate, and general interest race statistics.

City of Midland, Michigan
gis6.midland-mi.org/public/index.aspx
The interactive map is a public service mapping and information retrieval application that provides citizens with access to GIS data and information, such as aerial photography, property data, and other valuable community resources.

Singapore Uses GIS to Master Land-Use Planning

Highlights

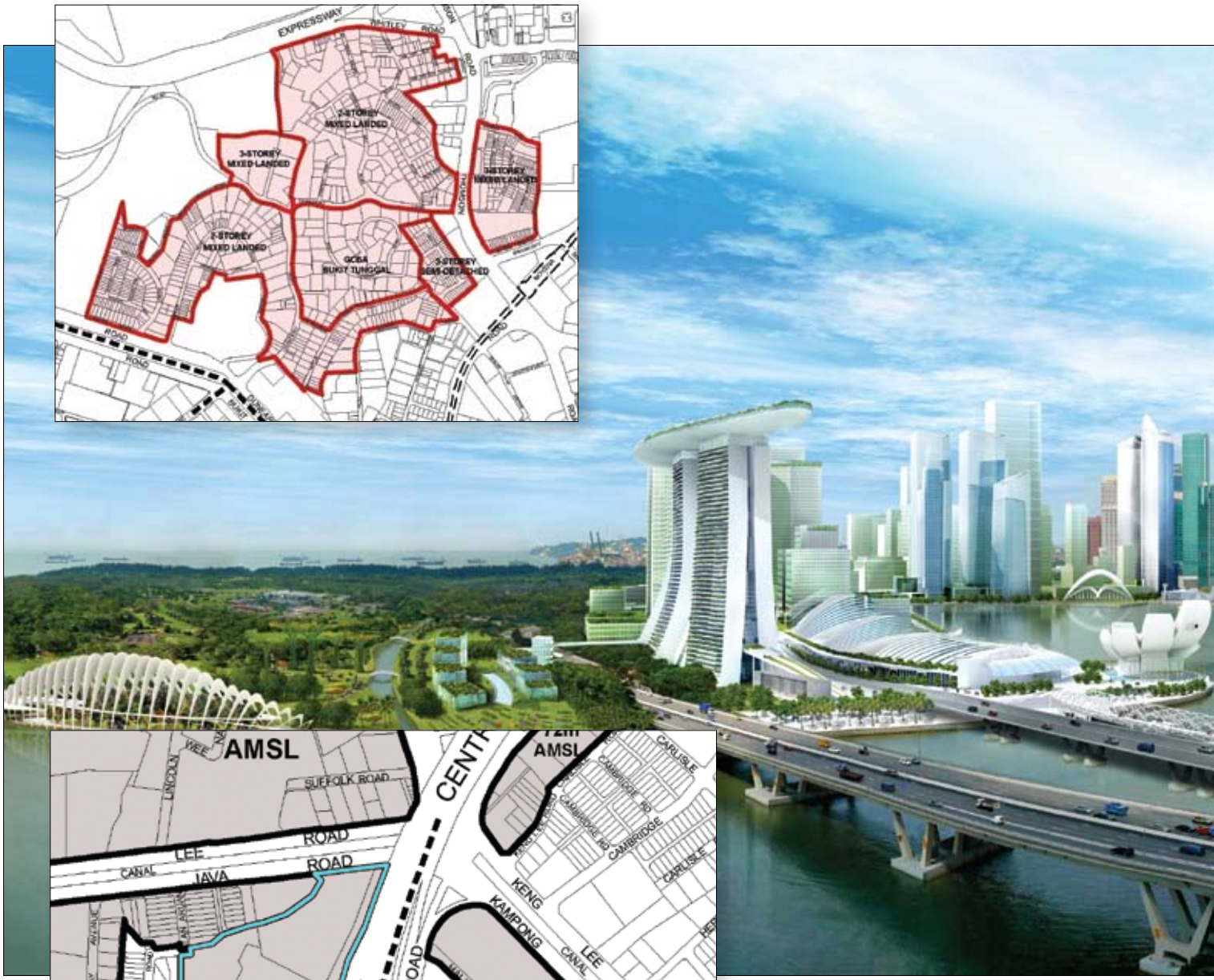
- Plans utilize ArcGIS to help guide development 40 to 50 years into the future.
- A customized ArcGIS Desktop application fits the workflow needs of the URA.
- More than 40,000 citizens viewed the GIS-based maps on the Master Plan Web site in just three months.

With a population of five million and a limited land area of 710 square kilometers (274 square miles), Singapore faces immense challenges in its land-use planning. Given its small size, careful planning is critical for the economic growth and future development of the country. Throughout the past 40 years since gaining its independence, Singapore has prided itself on sustainable development, which has allowed it to achieve economic growth appreciated by its citizens. By planning ahead and balancing land-use needs, Singapore believes it is possible for its land-scarce nation to continue to meet development and economic objectives without sacrificing a good quality of life.

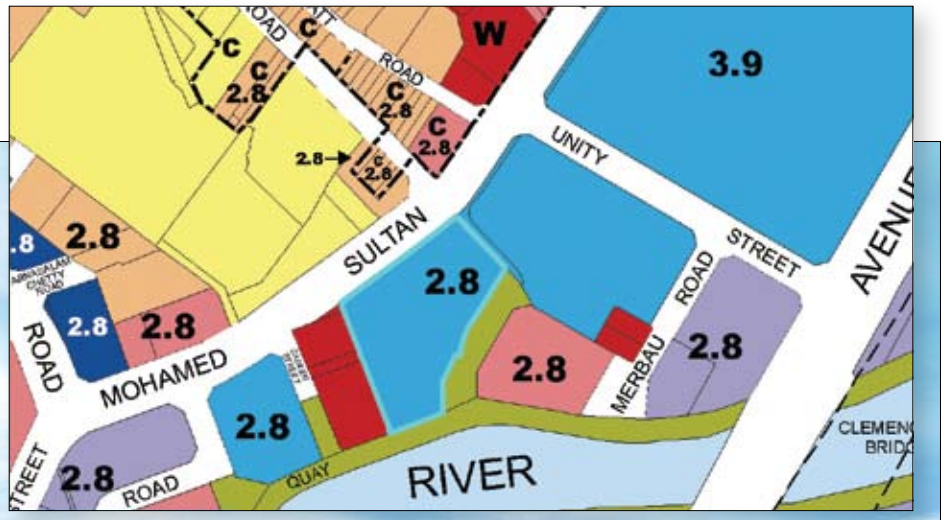
The Urban Redevelopment Authority (URA), Singapore's national land-use planning and conservation agency, is challenged with finding smart solutions so there will always be space for the needs of the island. URA prepares long-term strategic plans, as well as detailed local-area plans, for physical development, then coordinates and guides efforts to bring these plans to reality. The organization's mission is to keep Singapore a great city to live, work, and play in. It carries out its mission by planning and facilitating the physical development of Singapore in partnership with the community to create a global city of distinction.

Singapore adopts a centralized planning approach while ensuring a judicious use of land so as not to compromise its ability to meet future needs. This is done through URA's preparation of the Concept Plan and the Master Plan, both of which provide a comprehensive, forward-looking, integrated framework for sustainable development.

The Concept Plan is Singapore's strategic land-use and transportation plan to guide development in the next 40 to 50 years. The Concept Plan, which



Above left: Through the Master Plan 2008 Web site, citizens can view layers of data, such as housing areas. Bottom left: The Master Plan contains detailed GIS data and maps, such as a Building Height Control layer.



Top: The Master Plan shows a map of the permissible land uses for development in Singapore. Below: Artist's conception of the Marina Bay element of Singapore's Master Plan (courtesy: Urban Redevelopment Authority, Singapore).

is reviewed every 10 years, ensures that there is sufficient land to meet anticipated population and economic growth and provide a good living environment. It also ensures that future development balances economic growth with environmental stewardship and social progress. The Master Plan is a land-use plan that guides Singapore's development over the next 10 to 15 years. Reviewed every five years, the Master Plan translates the broad long-term strategies of the Concept Plan into detailed plans to guide Singapore's development. The Concept Plan and Master Plan are the result of extensive collaborative efforts involving key government agencies, and the sharing of land information and requirements by the agencies is an integral part of the land-use planning process.

URA's Integrated Planning and Land Use System (iPLAN) is an enterprise GIS used for urban planning. Operational since 2006, iPLAN enables URA's planners to carry out their land-use and strategic planning work effectively and efficiently. With iPLAN, URA is better able to deliver public services through the automation and integration of manual processes using IT and GIS.

URA subscribes to LandNet, a server GIS-based repository hosted by the Singapore Land Authority that contains more than 100 layers of geospatial data from more than 14 public agencies. Using the shared data from LandNet and the functionality in ArcGIS software, URA creates and edits the Master Plan maps for the internal use of staff, as well as publishing on the Internet for viewing by the general public.

URA's ArcGIS Server and ArcGIS Desktop software are used to create the plans, and the ArcGIS Desktop ArcMap application has been customized to meet URA's workflow requirements. The use of iPLAN has enhanced productivity and enabled faster decision making through better data integration and accessibility. Using the ArcGIS Server platform, about 200 URA employees can access needed GIS data directly from their desktop computers. Meanwhile, GIS data is diffused through better access to fundamental workflow tools, such as simple data retrieval services or editing applications.

In 2008, URA exhibited and published the draft Master Plan 2008 for online public consultation. During the consultation period from May 2008 to December 2008, more than 200,000 people visited the dedicated Web site to view and give feedback on the planning proposals. The Master Plan 2008 was gazetted in December 2008 after incorporating the relevant feedback and suggestions from members of the public and stakeholders.

"Enabling quick and easy access to the Master Plan allows citizens to participate in the land-use planning process. It also gives them a glimpse of the future developments in the city and the areas where they live," says URA's senior planner, Tan Chia-Li.

GIS supports URA's long-term, integrated planning and delivers government services more efficiently.

More Information

For more information, contact Goh Chye Kiang, senior systems analyst, Urban Redevelopment Authority, Singapore (e-mail: GOH_Chye_Kiang@ura.gov.sg), or Tan Chia-Li, senior planner, Urban Redevelopment Authority, Singapore (e-mail: TAN_Chia-Li@ura.gov.sg).

College Town Adopts Rooming House Registration

GIS Helps Tallahassee, Florida, Reduce Noise, Illegal Parking

Highlights

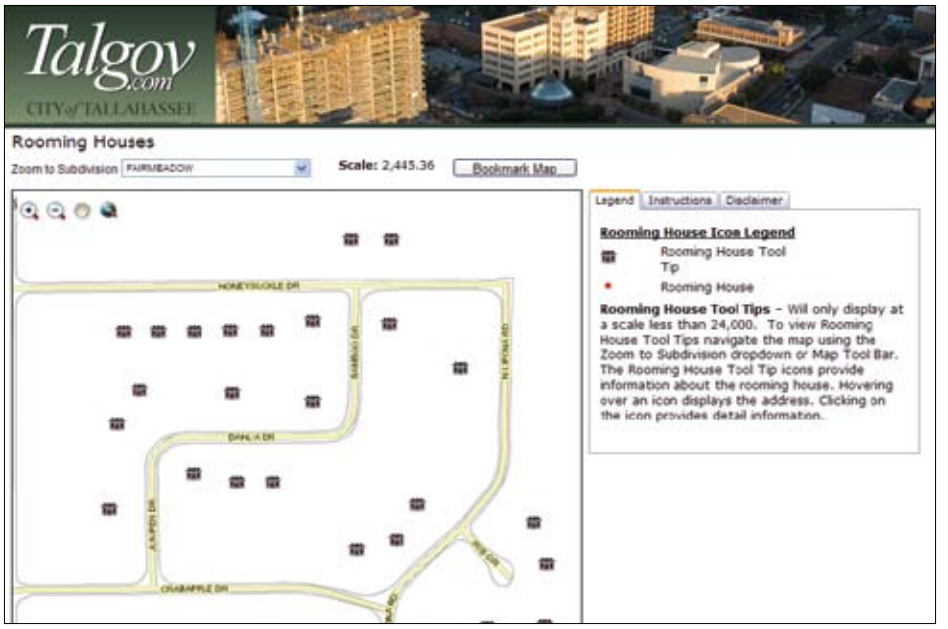
- Maps generated by ArcInfo are published to ArcGIS Server.
- Interactive map reduces the number of phone call complaints.
- Web site allows citizens to contact the rooming house agent.

Tallahassee is not only the capital of Florida, it is also a college town—home of Florida A&M University, Florida State University, and Tallahassee Community College. These schools have a combined enrollment of approximately 60,000 students, which brings an increased demand for rental units.

Often, the rental units are single-family dwellings in residential communities and draw complaints from neighbors about party noise and cars parked on lawns. These residents feel that property values are being threatened by the actions of these renters.

In response to neighborhood concerns, the Tallahassee City Commission adopted the Rooming House Ordinance in September 2000 to address dormitory-style housing in existing single-family residential neighborhoods. The ordinance is designed to help protect the character and stability of the city's neighborhoods while respecting individual property rights.

The ordinance established a registration process that prohibits rooming houses in single-family residential zoning districts, with the exception of those existing before June 2001. As part of the registration process, property owners must appoint an agent who lives in the county to be responsible for the property. This designated agent, who must be available 24/7, receives all notices from the city concerning the use of the property. Rooming house owners are required to register annually with the city's Growth Management Department. The Code Enforcement Division of the department is responsible for maintaining the listing and monitoring the properties by pinpointing registered properties and ascertaining relevant information. The city relies on ArcInfo as a result of many years of using ESRI products and being pleased with its functionality. Before using ArcInfo, this information was only listed in table format with no visual representation.



The Rooming House Tool Tip icons provide information about the rooming house, such as address and other detailed information.

The Growth Management Department has made the map interactive and available to citizens via the city's Web site so that they may contact the rooming house agent if there is a need or to determine if a house in their neighborhood has been designated as a rooming house.

The department started the initiative by taking the table of information and geocoding addresses against tax identification numbers. It then used symbology to show the properties, with little red-roofed houses as the points. When a citizen hovers the mouse pointer over a house, an information box pops up with the address and a message to click on the icon for more information. The available information includes the agent's name and contact number, the permit number, and whether the home is current on registration. The agent's name, contact number, rooming house number, and status are all queried from the Growth Management Department permit database.

ArcInfo is used in connection with ArcGIS Server: ArcInfo generates the map, which is published to ArcGIS Server, and is used to maintain and update the data that is seen by the public on the Web site; ArcGIS Server automatically updates the map from the changes made in ArcInfo.

This interactive map reduces the number of phone calls coming into the office, since citizens have the ability to search for properties to see the registered agents along with their phone numbers. There is also information available from the police department on the time, kind, and number of complaints issued against a property.

GIS has simplified a very difficult undertaking. With its ability to use mapping and information tools, as well as geocode addresses to parcel identification, GIS empowers citizens and allows the department to keep them updated while freeing staff to perform other duties.

More Information

For more information, contact Denise O'Neal, City of Tallahassee, Florida (e-mail: Denise.Oneal@talgov.com, tel.: 850-891-7073).

Infrastructure Inspection Streamlined

GIS Revitalizes Sewer Maintenance Capabilities in Ontario's Capital

Highlights

- City of Toronto uses GIS to ensure compliance with new reporting requirements.
- The city integrates GIS into its daily inspection operations.
- ArcView is used to create a complete snapshot of the city showing completed asset maintenance work.

In this view of the City of Toronto, the colored layers highlight the status of the assets. For example, yellow pipes have already been inspected, green pipes require cleaning, and red pipes are in danger of a possible collapse. Above right: The inspection application's video feature lets users simply click on an asset within the GIS to pull up a video of the asset.

Across Canada, sewer maintenance has become a growing priority among municipalities, and there has been a significant shift to rehabilitate sewer lines before they break. Factors such as aging infrastructure; population growth; poor quality control; and lack of consistency in design, construction, and operation practices have negatively impacted municipal infrastructure in recent years. Ontario alone has a massive backlog of water system repairs and an infrastructure deficit estimated in the billions, making it more important than ever for municipalities to implement a standardized process for acquiring and reporting reliable infrastructure data.

Toronto Water, the water department of the City of Toronto, Ontario, operates under a mandate of ensuring high water quality while protecting public health and safety and the environment. This objective is backed by the city's various improvement projects that include the continual inspection and maintenance of storm, sanitary, and combined sewer pipes. In 1998, when the City of Toronto amalgamated, Toronto Water was tasked with consolidating datasets from a variety of sources into a single system. This proved problematic, as data was stored in varying formats that were often difficult to access, for example, in files that were too large to download or on outdated media formats, such as VHS tapes. The city recognized that it was in urgent need of a standardized process so it could effectively compare inventory drawings against the realities in the field and verify structural defects in pipes, maintenance issues, and the accuracy of manhole positions.

In 2008, after a successful pilot project, the city commissioned CTZoom, a Montreal, Quebec-based firm and ESRI Canada Limited Business Partner, to install industrial inspection computers running its asset management software—CTSpec—in closed-circuit television trucks across the city. CTSpec is a data collection and analysis tool that leverages ArcView to provide a spatial component to infrastructure maintenance. With the software's video feature, users can now click an asset within ArcView to pull up a video of that asset.

Out with the Old, In with the New

Explains Antonio Longo, supervisor, District Contract Services, Toronto Water, "One of the biggest challenges with our previous asset management software was that inspectors and contractors would have to manually input road names and pipe and manhole numbers to analyze data on a specific asset, and this left a lot of room for error."

In addition, Toronto Water inspectors and contractors often recorded the results of their observations using the industry-specific data acquisition sewer.dat software. While this tool provided a mechanism to rate the conditions of the assets being assessed, it did not enable users to spatially view inspection data results.

But now, the city's new infrastructure maintenance program has strengthened city inspectors' ability to manipulate data. Inspectors and contractors just click an asset, and a header box pops up containing the desired information, such as name, location, and work required. They can quickly view a video and accurately assess inventory assets, and CTSpec also includes an automated tracking service that updates the status of asset conditions. The inspection unit's computers are synchronized with personal digital assistant (PDA) technology so that Toronto Water contractors can complete manhole and pipe diagnosis on handheld devices directly into a GIS that is easily shared with other contractors throughout the city.

A Snapshot of the City

The infrastructure maintenance program can now output ArcView software-based, multilayered digital maps that make it possible to proactively plan infrastructure maintenance activities. For example, a yellow layer identifies pipes that have been inspected, a green layer presents the operational performance grade of the pipe (the extent to which the pipe requires cleaning), and a red layer provides the structural integrity grade of the pipe so that inspectors can predict the likeliness of a collapse.

"We can now create a complete snapshot of the city," says Longo. "The spatial component lets us see the work that has been completed and identify work that still needs to be done."

The City of Toronto has now fully integrated GIS into its daily operations, which has improved both planning capabilities and cross-departmental access to information. For example, thematic maps can now be easily output by the operations team and forwarded to the asset management department so that it can prioritize assets in need of repair and accurately project its required budget for the coming year. This effective system of reporting ensures that the City of Toronto meets Public Sector Accounting Board compliance regulations, which require Canadian municipalities to include an accurate account of their tangible capital assets in annual financial statements by 2009, while enabling the city to identify and rehabilitate depreciating assets.

"We now use a five-point rating scale to assess the structural integrity and operational performance of assets and better understand the rate at which an asset will deteriorate, along with the projected useful life of that asset," explains Longo. "Once an inspection is complete, a report containing a list of inspected pipes and manholes, along with the date of the inspection and the site where the asset is located, is created."

"The real advantage of these reports is that each asset listed is hyperlinked to a movie, along with images of the pipe/manhole, and there is no need for extra software to view the images," says Alain Lortie, president of CTZoom. "This in turn enables the creation of a historical legacy of completed work."

More Information

For more information, contact Antonio Longo, supervisor, District Contract Services, Toronto Water (tel.: 416-392-4164), or Alain Lortie, president, CTZoom (e-mail: a.lortie@ctzoom.com; tel.: 888-965-8987, or 450-965-8987, ext. 222).

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Reducing Pollution on the Black Sea Coast

By Natalia Kurakina and Anastasia Minina, Department of Information Systems, St. Petersburg Electrotechnical University

Highlights

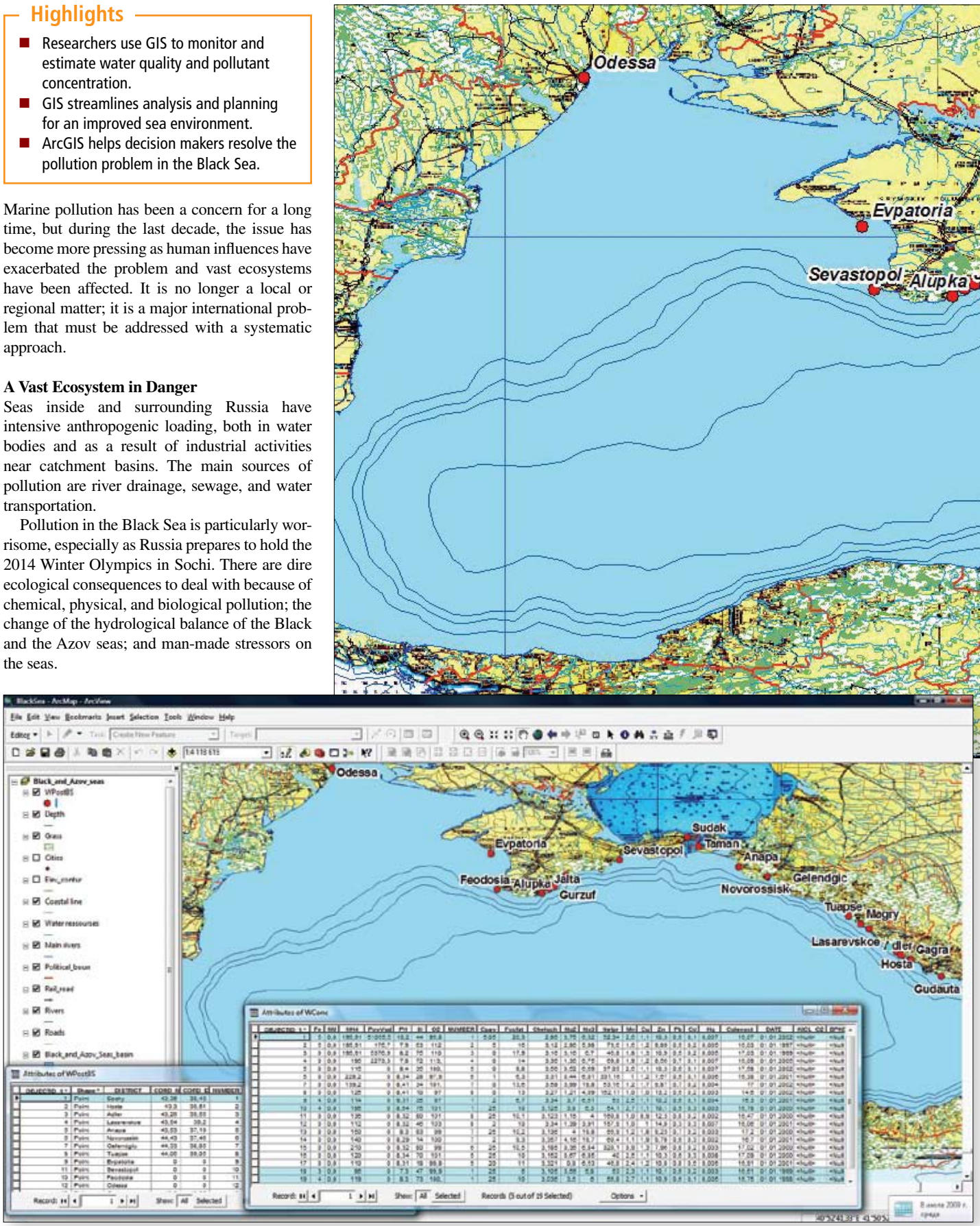
- Researchers use GIS to monitor and estimate water quality and pollutant concentration.
- GIS streamlines analysis and planning for an improved sea environment.
- ArcGIS helps decision makers resolve the pollution problem in the Black Sea.

Marine pollution has been a concern for a long time, but during the last decade, the issue has become more pressing as human influences have exacerbated the problem and vast ecosystems have been affected. It is no longer a local or regional matter; it is a major international problem that must be addressed with a systematic approach.

A Vast Ecosystem in Danger

Seas inside and surrounding Russia have intensive anthropogenic loading, both in water bodies and as a result of industrial activities near catchment basins. The main sources of pollution are river drainage, sewage, and water transportation.

Pollution in the Black Sea is particularly worrisome, especially as Russia prepares to hold the 2014 Winter Olympics in Sochi. There are dire ecological consequences to deal with because of chemical, physical, and biological pollution; the change of the hydrological balance of the Black and the Azov seas; and man-made stressors on the seas.



Designated observation sites along the Black Sea with tables for substance concentrations and for maximum permissible concentrations of pollutants.

Map of the Black and Azov seas, which is structured as separate layers: cities, rivers, seas, forests, roads, borders, railways, etc.

The Black Sea's deep waters do not mix with the upper layers of water that receive oxygen from the atmosphere. These hydrochemical characteristics, along with the Black Sea reservoir's climatic features and social/economic impacts of its use, influence the character of shelf vegetation, its vertical and horizontal distribution, and specific structure. Policy makers within the Russian Federation need accurate, up-to-date spatial data to be able to make informed decisions about water resource management.

There are many factors that influence the ecology of water bodies, and GIS makes analysis and planning for an improved sea environment easier with its visualization capabilities. Analysts at St. Petersburg Electrotechnical University are using ArcGIS software for data management, to create thematic maps, and to support stakeholders in decision making as they administer marine policies. They have developed a system for monitoring and estimating water quality that facilitates managing large amounts of data for mapping and analysis. This helps organizations set pollution standards and conduct appropriate wildlife management.

Developing the System

The process for creating the system to estimate water conditions uses ArcInfo software. The GIS contains the following:

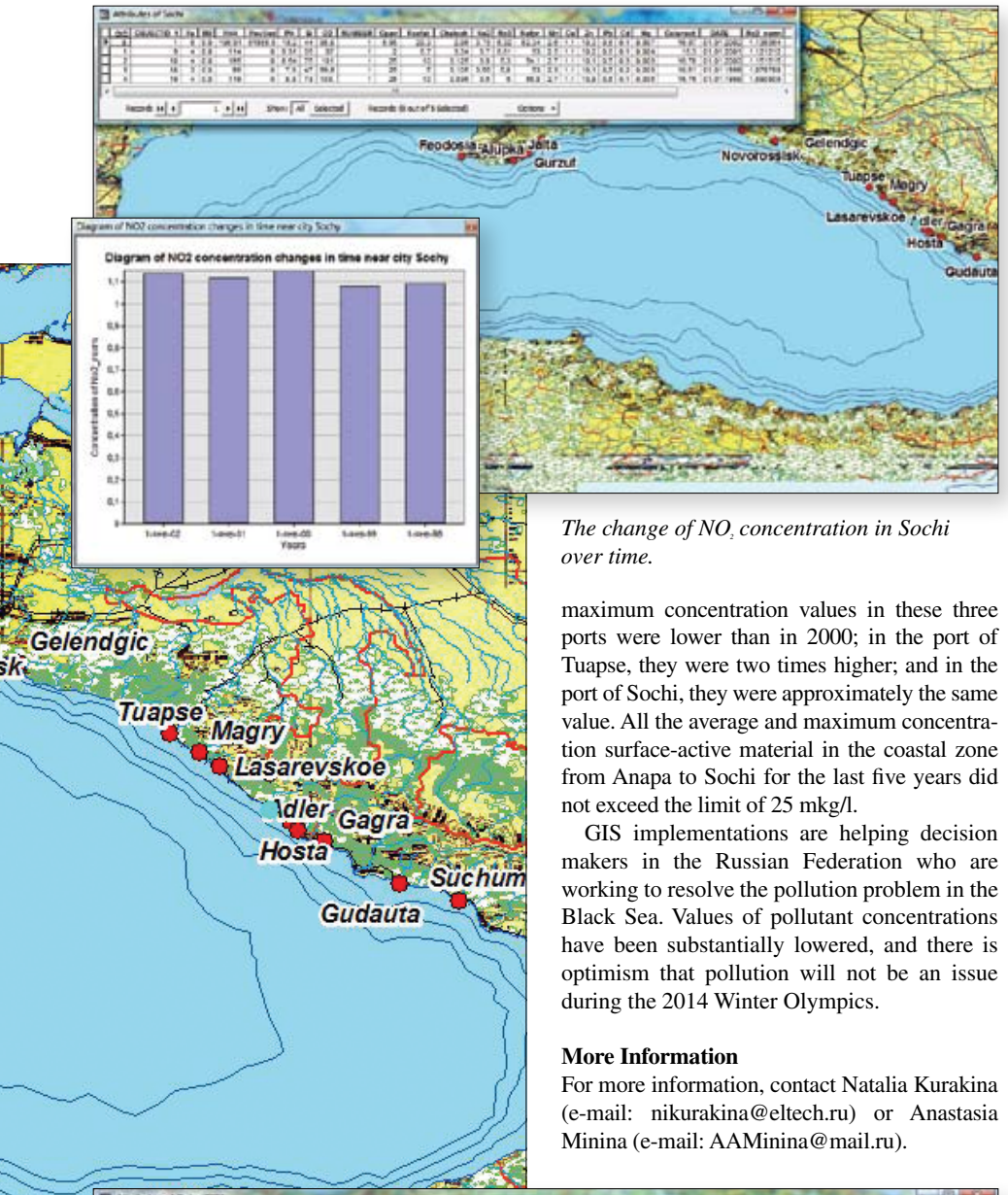
- Basemap, which includes cities, rivers, seas, forests, roads, borders, and railways
- Geodatabase of the ecological situation, including observation posts on the Black Sea, a table of pollutant concentrations, and a table of maximum permissible concentrations of pollutants

To estimate water quality, analysts compare data from observation posts with a control and calculate water characteristics using specific criteria. They can process large amounts of data to estimate when a specific observation post will exceed the maximum permissible concentrations of a pollutant. The analysts use this process to determine the changes in substance concentrations in the coastal area of the Black Sea. Values of a maximum concentration level are used as a measure of a water body's impurity.

Team members charted over time the changes of substance concentration, which they used to determine when an observation site would exceed the maximum permissible value of substance concentration. The interpolated values of pollution concentration at points where values were unknown was determined using ArcGIS Geostatistical Analyst.

Monitoring the Black Sea's Water Resources

The researchers discovered rather high concentrations of pollutants along the coasts of Sochi, Hosta, Adler, and Gelengic. Over time, the level of pollutants, such as hydrocarbons, stabilized and didn't exceed 0.03 mg/l in the ports of Anapa, Novorossisk, and Gelengic. The

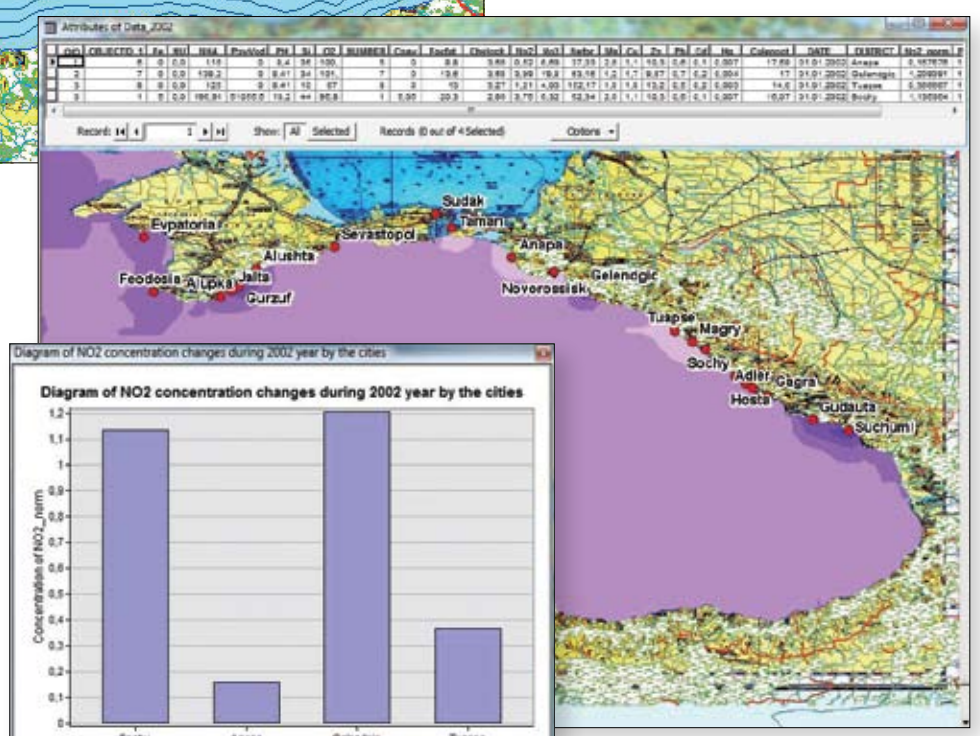


The change of NO_2 concentration in Sochi over time.

maximum concentration values in these three ports were lower than in 2000; in the port of Tuapse, they were two times higher; and in the port of Sochi, they were approximately the same value. All the average and maximum concentration surface-active material in the coastal zone from Anapa to Sochi for the last five years did not exceed the limit of 25 mkg/l.

GIS implementations are helping decision makers in the Russian Federation who are working to resolve the pollution problem in the Black Sea. Values of pollutant concentrations have been substantially lowered, and there is optimism that pollution will not be an issue during the 2014 Winter Olympics.

More Information
For more information, contact Natalia Kurakina (e-mail: nikurakina@eltech.ru) or Anastasia Minina (e-mail: AAMinina@mail.ru).



NO_2 concentration distribution.

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Improving Access to Clean Water in Sub-Saharan Africa

GIS Used to Explore the Spatial Dimensions of Public Health

Highlights

- GPS and GIS were used to classify water access points, such as wells, lakes, and cisterns.
- The fieldwork gave students hands-on experience in learning ArcGIS technology.
- Research helped analysts evaluate distance from households to clean water sources.

Clean drinking water is hard to find in Mayange, Rwanda.

That's why a group of university students and two professors from the University of Redlands (U of R) in Redlands, California, traveled to this African region. Using the GIS technology and GPS equipment they brought along, they mapped the area's water sources and collected water use information. Their survey is helping improve access to clean drinking water in the community and in similar communities across sub-Saharan Africa.

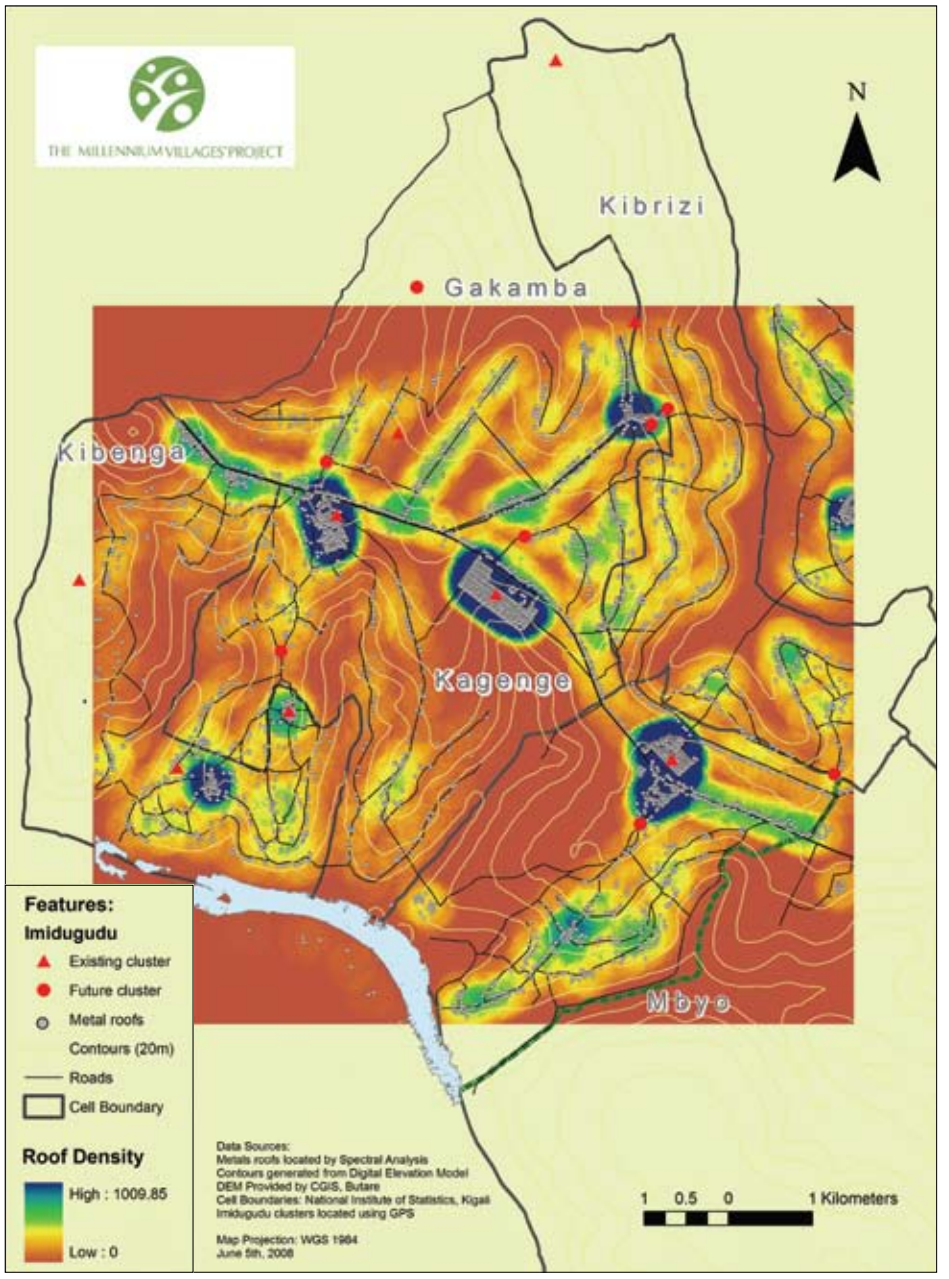
The maps are useful in providing local sustainable development programs with accurate locations of where people get their water. For example, the data can be used to identify areas where water sources are contaminated and support decisions about improving water quality, such as how to protect an open pit water source or where to dig a new water source. Ultimately, this field collection and mapping model may be used for mapping other water networks in Rwanda and other parts of Africa and to contribute to the implementation of sustainable practices in impoverished nations.

"Anything that we can do to improve water quality is going to have a major impact on the population," says Maxwell Baber, Ph.D., associate professor in the Master of Science in Geographic Information Science program at U of R. Baber and Katherine Noble-Goodman, a visiting lecturer in environmental studies at the university, led U of R undergraduate environmental studies students to the rural Mayange sector in 2008 and 2009.

In the bigger picture, the project contributes to an ambitious plan—the Millennium Development Goals (MDG)—that pledges to eliminate extreme poverty worldwide by 2015. Representatives from 192 United Nations (UN) member states signed on to the UN's MDG commitment to reduce poverty by improving health, education, agriculture, and infrastructure. Access to clean drinking water plays an important part in supporting these goals. MDG aims to reduce by half the proportion of people without sustainable access to safe drinking water.

Some progress has been made in advancing MDG goals, but in sub-Saharan Africa, improvements have advanced more slowly than in other parts of the world. As a result, the Millennium Villages Project (MVP) was established to create a successful model in Africa for alleviating poverty using a set of integrated, community-driven activities.

Mayange, with a sector population of 25,000, is one of 80 MVP participants spread across 10 African countries. Located in one of the poorest regions in Rwanda, the area is almost completely deforested and receives 800 millimeters (about 31.5 inches) of intermittent annual rainfall. As in many other rural African areas, Mayange villagers spend hours each day retrieving water their families need to survive. Often, the water source is contaminated, which can cause health problems. The time-consuming retrieval process also diverts efforts from activities crucial to sustainable development, such as education and farming.



This map shows building density and estimated housing expansion areas in the Mayange sector.

"Clean, reliable sources of water for drinking, cooking, and other basic human needs are a necessary condition for the elimination of poverty and the success of sustainable development," says Noble-Goodman. In Rwanda, more than 25 percent of the population lacks access to clean water.

Using Garmin GPS equipment and ArcGIS (through their ESRI University Site License), the teams spent a total of 15 days in May 2008 and 2009 in the field mapping and classifying water access points, such as wells, lakes, and cisterns. With help from local village leaders and guides and personnel from Rwanda National University and MVP, the students built a database of water sources by collecting GPS points and classifying each site as a shallow well, open pit, lake, deep borehole, water tap, or cistern.

The teams also collected survey data by talking with individuals who arrived at the sites to fill their water cans. The survey provided information on water use, household location and size, distance to the water source, and the seasonal availability of water. The survey's purpose was to help MVP participants prioritize areas in most need of improving the quality and quantity of water sources. "One goal of MVP is to have water within one kilometer of every household. This is very ambitious and will take a while," notes Molly Moore, a U of R student who participated in the project.

The data is being held by Didace Kayiranga, MVP science coordinator in Mayange. "It gives us tools for planning and to evaluate our indicators, such as distance from a household to a clean water source," says Kayiranga. "This indicator cannot be easily measured without overlaying the different household and water point layers."

The fieldwork gave students hands-on experience in learning how GIS technology can support projects that study the relationship between humans and the environment.

"And for a few days in May," adds Noble-Goodman, "students had the opportunity to help improve the community's access to clean, safe water."

U of R faculty and students continue to edit and revise the project data in graduate GIS classroom studies as a way to explore the spatial dimensions of public health issues. They are running analyses and creating spatial models to predict relative likelihood of productivity for new borehole well site locations. The most commonly employed model inputs are derived from household density (as analog for population density, to incorporate proximity to population concentrations) and relative terrain situation (valley or ridge, for relative proximity to groundwater).

More Information

For this project, U of R collaborated with Loma Linda University School of Public Health (**www.llu.edu/llu/sph**), the Millennium Villages Project (**www.millenniumvillages.org**), and National University of Rwanda Geographic Information Systems and Remote Sensing Centre (**www.cgisnur.org**). Grant money was provided by the Southern California Metropolitan Water District. Note: Maxwell Baber now holds the position of director of academic programs, U.S. Geospatial Intelligence Foundation.

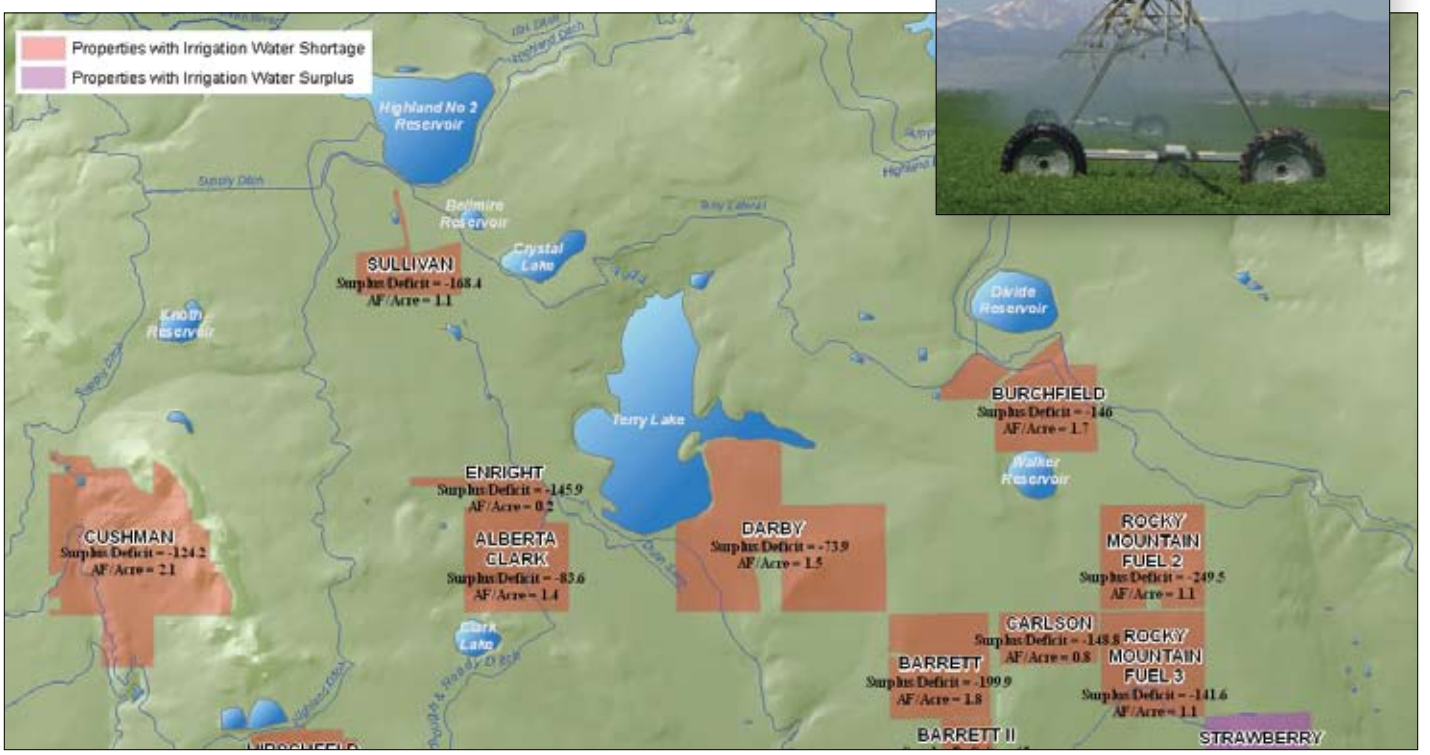
Managing Agricultural Water Resources Successfully

Boulder County Parks and Open Space Creates Innovative GIS-Based Tool

By Kristi VanDenBosch, Boulder County, Colorado, Parks and Open Space Department

Highlights

- AgHydro is a tool to better inform the human decision-making process for managing water resources.
- The editing process is controlled to ensure quality data through versioning.
- ArcGIS Desktop analytic tools help make complex relationships more accessible.



Agricultural irrigation water shortage and surplus in the Highland Ditch Study Area. Red indicates properties with water shortages, and purple indicates properties with surpluses. The numbers indicate the water shortage or surplus amount in acre feet for that property and water supply in acre feet per acre. Inset: Center pivot irrigation sprinkler on Boulder County Parks and Open Space agricultural land.

The Boulder County, Colorado, Parks and Open Space (BCPOS) program began in 1975 as a single property—the 101-acre Bald Mountain Scenic Area. Since that first acquisition, the BCPOS program has grown to more than 97,000 acres, including directly owned properties and conservation easements held over private property. These properties range from subalpine ecosystems along the Continental Divide to the agriculturally productive lands of the high plains. This land investment is worth more than $317 million, paid for by the citizens of Boulder County. In addition to the land, BCPOS has purchased numerous water rights. These water resources have a value in excess of an additional $60 million. The BCPOS program has the responsibility to manage these resources for diverse, and sometimes competing, purposes, including preserving critical ecosystems and natural resources, the agricultural heritage of Boulder County, and historic and archaeological landmarks; sustaining scenic vistas; maintaining urban shaping between or around municipalities; and providing public recreational opportunities.

The largest use of water in the open space system has been, and is likely to remain, the agriculture program, which encompasses 45 percent of the fee-owned property and uses. The agricultural program operates by leasing lands and water to local private farmers. These farmers, within the framework defined by Boulder County, make production decisions: which crops to produce, which products to apply, and when and how much to irrigate. The county's responsibility is to provide sufficient resources to allow farmers to maximize their production and to offer technical assistance, guidance, and oversight.

Making decisions about the management of water resources for agricultural production requires a thorough understanding of complex information, including climatic conditions, natural and artificial water systems, agricultural practices, and legal conditions. BCPOS recognized that with a better understanding of the spatial distribution and relationships of these resources, managers could make better decisions. For example, knowing where water supply is insufficient for production can help staff make decisions about which water to add to the water portfolio or where to focus irrigation conservation methods. This information can also help clarify agricultural water resources decision intricacies for nonexpert decision makers by clearly laying out methodologies and representing results in a graphic format.

The AgHydro Application

Since 1987, GIS technology from ESRI has become an integral part of almost all Boulder County's governmental functions: property assessment; land-use and zoning issues; road construction and maintenance; emergency and law enforcement; snowplowing; open-space acquisitions, operations, and management; wildfire mitigation; health concerns; and precinct delineation.

In recent years, BCPOS designed a GIS, named AgHydro, to better inform the human decision-making process for managing the water resources of Boulder County. The system was created using ArcGIS 9.3 software. The GIS integrates data from various formats, locations, and spatial scales. Spatial data used in the GIS is primarily vector data, such as the agricultural field delineations and hydrological features. All spatial data is housed in ArcGIS Server. This enables BCPOS to control the editing process to ensure quality data through versioning. Tabular data resides mainly in Oracle relational databases, with some data stored as geodatabase tables. BCPOS has an existing agricultural database that tracks information on all the agricultural management activities that occur on open-space properties. Information in this database includes the types of crops planted; amount of irrigation water, fertilizer, and pesticides applied to these crops; and crop yield at harvest. The crop type is used to determine the irrigation water requirement for each field and property. BCPOS also maintains an Oracle database designed to inventory and manage property, mineral and water rights owned by the county, and agricultural leases administered by BCPOS.

Using the analytic tools available in ArcGIS Desktop, such as the ArcGIS Network Analyst and ArcGIS Geostatistical Analyst extensions, the BCPOS AgHydro GIS enables decision makers to better understand the real-world elements and complex relationships of a given problem or scenario. The AgHydro application increases the level of understanding of the components comprising the county's land and water resources. Understanding the individual components allows managers to better understand the effect that the components have on the irrigation system and agricultural processes as a whole. Other variables that are not included in the GIS may need to be considered, such as the price and availability of water, Boulder County community values, and legal constraints.

Highland Ditch

The most valuable information that resulted from the spatial analysis was the amount of water available for supply and the calculated water demand for each property in the Highland Ditch study area. BCPOS staff members were aware that there was an irrigation water deficit on the properties irrigated under the Highland Ditch, but the ArcGIS software-based AgHydro showed these properties to be even more depleted than the general perception—over 100 acre feet short in some cases. Knowing both that these properties are water short and the extent of that shortage, as well as the effect of different agricultural and water management approaches, will help staff make better management decisions, such as fully evaluating an opportunity to purchase additional water or installing infrastructure to maximize the irrigation water potential.

AgHydro enables the BCPOS data to be combined in many ways to provide further insight into agriculture and water management, whether it is examining data at different scales or running different scenarios to examine the various outcomes. For example, additional information, such as ditch run dates, the price per unit of water, and the potential properties that a given unit of water can serve, can give further insight into prioritizing potential water purchases in the future. Subsets of data can be isolated so that managers can examine results between years, within selected water systems, or for a given crop.

Gut Instincts Can Fail

"The GIS proved to be a valuable tool in increasing our understanding of the agricultural water distribution system and increased the quality of our decision-making process," says Rob Alexander, agricultural specialist at BCPOS. "Our confidence in decisions about where to allocate our budget and how to manage our irrigation water resources is now based on a much greater foundation of accurate information. In many cases, our educated 'gut instincts' can be way off. We thought that our on-the-ground knowledge after 13 years would be sound and that decisions based on that knowledge would be good ones. Turns out we were wrong. In some cases, we were not even close." Based on these results, BCPOS plans to expand the project from the current pilot project area to cover the water distribution systems countywide.

About the Author

Kristi VanDenBosch is a GIS analyst with the Boulder County Parks and Open Space Department with an M.S. in GIS and watershed science and nine years of GIS experience.

More Information

For more information, contact Kristi VanDenBosch, Boulder County Parks and Open Space Department (kvandenbosch@bouldercounty.org).

Wyoming Shares Water Resources Data

GIS Used to Provide Hydrological, Climatological Information

By Chris Nicholson, Tony Bergantino, and Steve Gray,
Water Resources Data System, University of Wyoming

Highlights

- Customized ArcIMS applications serve many stakeholders.
- Individual point locations for water and a variety of climate records can be viewed against backdrops.
- The Web-mapping applications are linked to the State Engineer's database of all groundwater wells in the state.

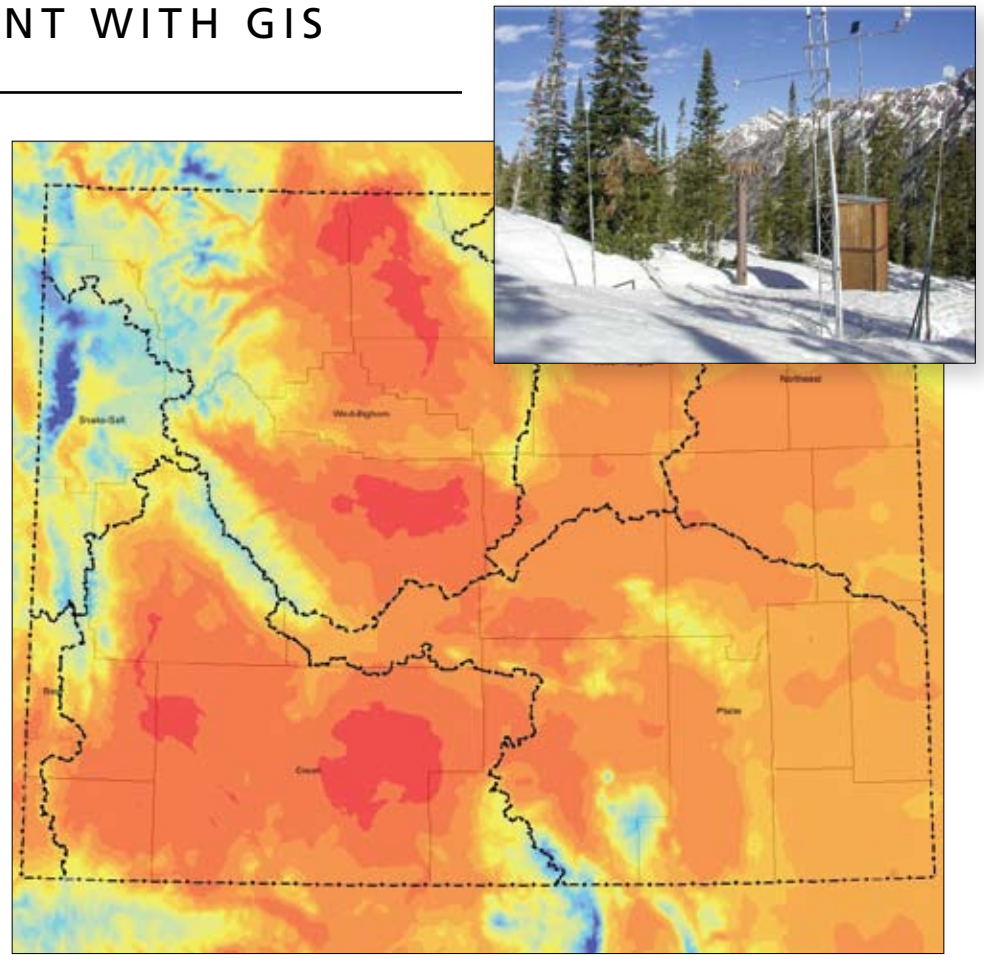
From the snow-packed peaks in Grand Teton National Park to the harsh, dry plains of the Red Desert, Wyoming is truly a land of climate extremes. As the fifth driest state in the United States, Wyoming is constantly threatened by drought. Since 1999, much of Wyoming has been gripped by moderate to severe drought, prompting the state to take careful account of its water resources. To help meet those demands, the Water Resources Data System (WRDS) at the University of Wyoming provides both hydrological and climatological information to the public and to federal, state, and local agencies. WRDS offers extensive current and historical spatial data with related attribute information. With so much of the water data in Wyoming linked to spatial attributes, WRDS has taken steps to disseminate all this data via the Internet to water managers, legislators, and stakeholders across the state.

GIS and Wyoming's Water Resources

WRDS has long been a library and data repository for Wyoming water- and climate-related information. WRDS is often tasked with the creation of maps for various water plans around the state, and this is accomplished using different GIS applications. WRDS has taken advantage of the University of Wyoming's ESRI University Site License and made available water and climate data using customized ArcIMS services. Publishing this type of data via customized ArcIMS applications allows numerous water stakeholders to examine how different areas of the state are developing and using existing water and to determine where in the state those resources may be most sensitive to changes in climate, shifts in demand, and increasing human populations.

Streamflow, Precipitation, and Climate

WRDS' core water- and climate-related applications link users to the U.S. Geological Survey's stream gauge network (waterdata.usgs.gov/wy/nwis), thereby allowing access to real-time and historical stream flow data for Wyoming. Users are also provided with links to station metadata and information about these records. Likewise, WRDS is able to link users to snowpack telemetry (SNOTEL) sites that record snowpack data from across the state (www.wcc.nrcs.usda.gov/snotel) and to a wide range of meteorological observations and climate data housed at the Western Regional Climate Center (www.wrcc.dri.edu).



Average annual precipitation from 1971 to 2000 across Wyoming. Inset: Natural Resources Conservation Service SNOTEL site.

In addition to the "one-stop shopping" that these applications offer, ArcIMS allows WRDS to provide a rich context for this information. Individual point locations for water and climate records can be viewed against backdrops ranging from aerial photography to maps of landownership.

Groundwater Resources

The Wyoming State Engineer's Office maintains a database of all groundwater wells in the state. WRDS' Web-mapping applications are linked to this database, allowing users to locate groundwater wells and find information, such as actual yield and the depth to the top of the mean water-bearing zone for each site. Currently, users can view well locations in relation to climate and surface water features, as well as bedrock geology. In the near term, plans call for the addition of recharge-zone maps and soils to these applications. With the combined pressures of water shortages and energy production becoming more prominent in the state, it is essential that users be able to examine these groundwater resources in detail and better understand their place in the broader landscape.

Irrigated Lands

The high plains of Wyoming require irrigation in order to sustain agriculture, and as a result, irrigation accounts for the majority (more than 80 percent) of water use in the state's seven river basins. Approximately 1,947,000 acres are irrigated in the state, a number that has steadily increased over the past 30 years. By using ArcIMS, WRDS can show users where these irrigated lands are located and connect them to water rights information associated with each parcel. Users may also view features related to the management of irrigation water (e.g., irrigation district boundaries) and irrigation-related infrastructure (e.g., diversion dams).

Public Water Systems

Since 1998, the Wyoming Water Development Office (WWDO) has conducted biannual surveys of public water systems in the state. These surveys provide the most comprehensive and up-to-date sources of information on water rates, operating criteria, and infrastructure needs throughout Wyoming, and WRDS' ArcIMS tools provide the public and decision makers alike with ready access to this data. These surveys and the data they generate are fast becoming a key component of WWDO's funding criteria and an important aid in prioritizing feasibility studies and project construction needs.

Online Water Library

The WRDS Water Library is a comprehensive collection of more than 21,000 documents and is a resource for individuals seeking in-depth information on the state's water resources. Every year, the State of Wyoming commissions reports on water projects ranging from municipal water supply repair and pipeline construction to instream flows. WRDS has dynamically linked the Water Library's report collections to these tools, thereby providing engineers, researchers, and the public with access to key water-related documents. This not only streamlines the process of searching for water resource material but also allows easier distribution of electronic documents throughout the state and region.

WRDS is now able to reach a large audience and provide it with vital information on Wyoming's most precious resource—water.

About the Authors

Chris Nicholson is the outreach and technology coordinator for WRDS. Tony Bergantino is the programmer analyst executive and assistant state climatologist for WRDS. Steve Gray is the Wyoming State climatologist and WRDS director.

More Information

For more information, contact Chris Nicholson (e-mail: cnichol5@uwyo.edu, tel.: 307-766-3741) or visit waterplan.wrds.uwyo.edu/Website/Statewide, www.wrds.uwyo.edu, wwdc.state.wy.us, or waterplan.state.wy.us.

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Combating the Asian Tiger Mosquito

For the County of Mercer, New Jersey, Mosquito-Borne Diseases Pose a Serious Challenge

By Matthew Kabak, Eric Williges, Isik Unlu, Matthew Lawson, and Ary Farajollahi, County of Mercer, New Jersey

Highlights

- GIS was used to develop policy, plan daily inspection routines, and manage data.
- GPS data points are imported into ArcGIS feature classes and activated on top of vector and raster layers.
- GIS allows entomologists to make rapid, efficient comparative assessments.

The County of Mercer, New Jersey, lies equidistant between New York City, New York, and Philadelphia, Pennsylvania. Its geography ranges from Appalachian piedmont forests to farms on the coastal plain. It hosts extensive freshwater and tidal marshes, the state's urban capital of Trenton, and a booming interstate "edge city" near Princeton University. Such diversity provides an ideal location to study mosquitoes and arthropod-borne diseases (arboviruses).

Mercer County Mosquito Control (MCMC) monitors, inspects, and manages all mosquito-related activities within the county. Its two main responsibilities are to monitor and control nuisance mosquito populations and to protect the safety of the general public from mosquito-borne diseases, such as West Nile virus and eastern equine encephalitis. MCMC uses integrated pest management techniques, along with continual surveillance of local mosquito populations and responses to service requests generated by local residents, to keep mosquitoes at tolerable levels.

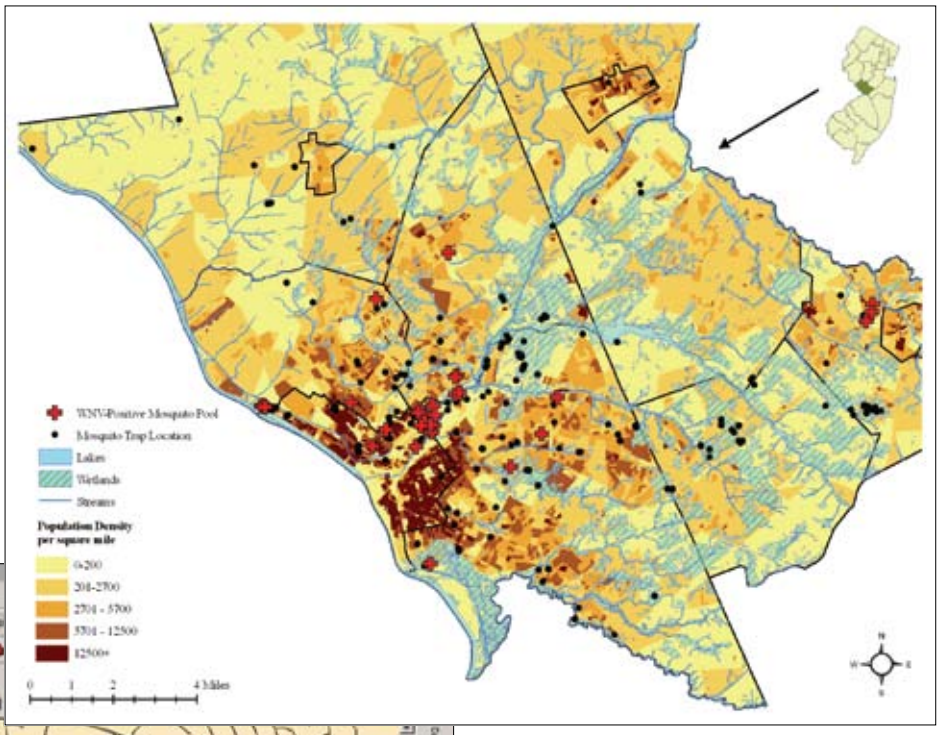
In recent years, populations of an invasive mosquito species, *Aedes albopictus,* the Asian tiger mosquito, have been increasing dramatically. This species poses a serious challenge because of its daytime biting habits, ubiquitous larval habitats, and danger as a disease vector. In fact, six arboviruses (eastern equine encephalitis, West Nile, Keystone, Tensaw, Cache Valley, and Potosi) have been isolated from this species since its introduction into the United States. Additionally, this mosquito is an efficient vector of other nonendemic arboviruses such as dengue, yellow fever, and chikungunya. With globalization and modern travel patterns, it may be only a matter of time before an infected traveler imports one of these exotic diseases.

From a management perspective, MCMC has a great deal of spatial information to track, including larvicide applications for regulatory compliance, lab test results from trapped mosquitoes, and animal and human disease incidence for epidemiological purposes. For this reason, MCMC was one of Mercer County's early adopters of GIS to help manage data. MCMC currently uses ArcGIS Desktop software and ArcSDE 9.2 with Microsoft SQL Server 2005 to develop policy and daily inspection routines and manage most data.

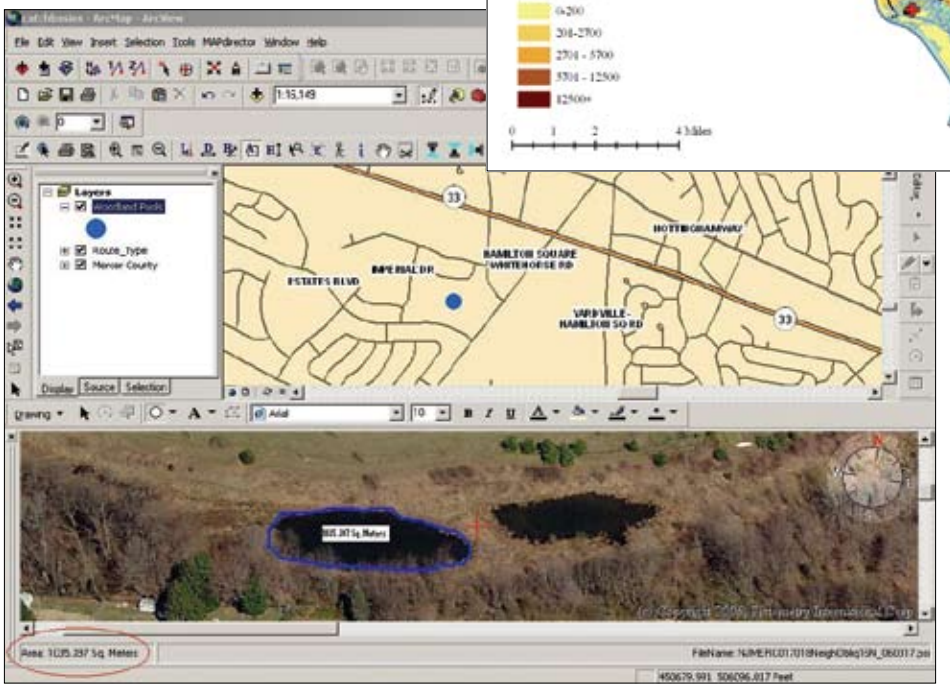
Ron Oppenheimer, a mosquito inspector, states, "GIS not only provides me with an accurate visual depiction of where mosquito habitat is located, it also allows me to visualize where other hidden potential habitats may lie."

The countywide GIS consists of an enterprise geodatabase managed with ArcGIS Server Advanced Enterprise and hosted at the county administration building in Trenton. From offices seven miles away, MCMC accesses hydrologic, topographic, transportation, and demographic feature classes in the enterprise geodatabase by consuming server-cached map services. In addition, MCMC also uses local personal geodatabases, managed with ArcGIS Desktop applications, to maintain spatial data specific to mosquito control issues, including, most recently, data for a consortium research project on the surveillance and management of the invasive Asian tiger mosquito. This local data addresses a wide variety of needs, from tracking pesticide usage by each inspector across the course of a season to creating specific maps in response to a resident complaint or question.

MCMC also uses other GIS-related tools. One is an industry-specific vector management system with integrated GIS capabilities for mosquito and vector control programs. The system allows managers to efficiently organize, host, and report mosquito data, which can be exported in a shapefile format and added as a layer in the ArcGIS Desktop ArcMap application. Another tool is the Pictometry image viewer extension to ArcMap from ESRI Business Partner Pictometry International Corp. (Rochester, New York). With



Vector surveillance results collected during 2008 in Mercer County, New Jersey.



The viewer tool is used to display a woodland pool (popular mosquito habitat) vector point on an oblique aerial photo. With this tool, MCMC can then accurately view and measure landscape features to select appropriate countermeasures.

oblique and orthogonal aerial image libraries from 2005, 2007, and 2009, MCMC staff can view high-resolution imagery (6 inches per pixel) from several angles and several points in time. The approximate 40-degree angle of the oblique imagery and leaf-off flight schedule provides them with greater detail than common orthogonal images. By analyzing these images and comparing them with field comments from inspectors, it is possible to narrow down the reason for a local service request before sending any inspectors to the field.

MCMC's team of inspectors provides surveillance and control of local mosquito populations across Mercer County. In the field, team members use Trimble GeoXT GPS units and Pathfinder software from ESRI Business Partner Trimble Navigation Limited to track trapping and treatments at active mosquito sites and record work in response to residents' service requests. GPS data points are imported into ArcGIS feature classes and activated on top of vector and raster layers. This gives supervisors a visual way to identify hot spots around the county in which a cluster of data points could correspond to high mosquito populations or disease activity. Mosquitoes are collected with a variety of vector surveillance traps and tested in the laboratory to determine the presence and prevalence of diseases such as West Nile virus and eastern equine encephalitis. After test results are imported into ArcGIS, supervisors can visualize virus activity and deploy inspectors to control adult mosquito populations in a precise and targeted manner. Maps of disease incidence and pesticide applications are used to compare current activity to historic activity and ensure that MCMC serves the county as efficiently as possible.

MCMC's study and control of *Aedes albopictus* offers a valuable example of GIS/GPS technologies at work. Introduced into the United States in 1985, the species now infests 30 states and continues to expand its range. The species was first detected in New Jersey in 1995, and its range has expanded to all but the far northwest corner of the state. Public health officials concerned with arboviruses recognize this species as a potential vector of debilitating epidemics, but it is also regarded as one of the most significant nuisance mosquitoes across its range. *Ae. albopictus* is an aggressive and persistent human-biting species that, in contrast to most mosquitoes, feeds during the day and can significantly impact human environmental quality. This mosquito thrives in artificial containers, even bottle caps, particularly in urban areas, and has been responsible for most of the service requests from Mercer County residents in recent years. Standard approaches to mosquito abatement fail to control this species, due to its unique behaviors. For an urban pest such as *Ae. albopictus,* an area-wide approach for control is imperative, since populations are diffuse and the potential for dispersal to neighboring properties is high.

To combat the *Ae. albopictus* infestation and develop best practice interventions, MCMC is participating in a multidisciplinary research study that incorporates demographic and land-use analysis, extensive public education and involvement, and focused application of established biological and chemical control interventions.

The Asian tiger mosquito study uses advanced geoprocessing and geostatistical tools in ArcGIS. Using data from enterprise and personal geodatabases, the research team selected three experimental areas in the city of Trenton similar in census block size, tax parcel size, economic factors, and population density of Asian tiger mosquitoes. Team members selected, clipped, and merged study areas using parcel and street centerline layers. Census blocks clipped to the study areas were enumerated and stratified into site locations. At the end of the mosquito season, surveillance, treatment, and service call data for each risk unit can be laid over various hydrologic, demographic, and topographic feature classes to allow visual and statistical study of outcomes. Analysis will use ArcGIS and other applications to predict and model prime *Ae. albopictus* habitats. This will permit rapid deployment of mosquito inspectors.

About the Authors

Matthew Kabak is a GIS specialist for Mercer County, Eric Williges is a wetlands specialist for MCMC, Isik Unlu is an entomologist for MCMC, Matthew Lawson is a principal planner for Mercer County, and Ary Farajollahi is the superintendent for MCMC.

More Information

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Disease Causing Steep Decline of Bats

Mapping the Spread of White-Nose Syndrome with GIS

By Mylea Bayless, Bat Conservation International, and Zachary Wilson

Highlights

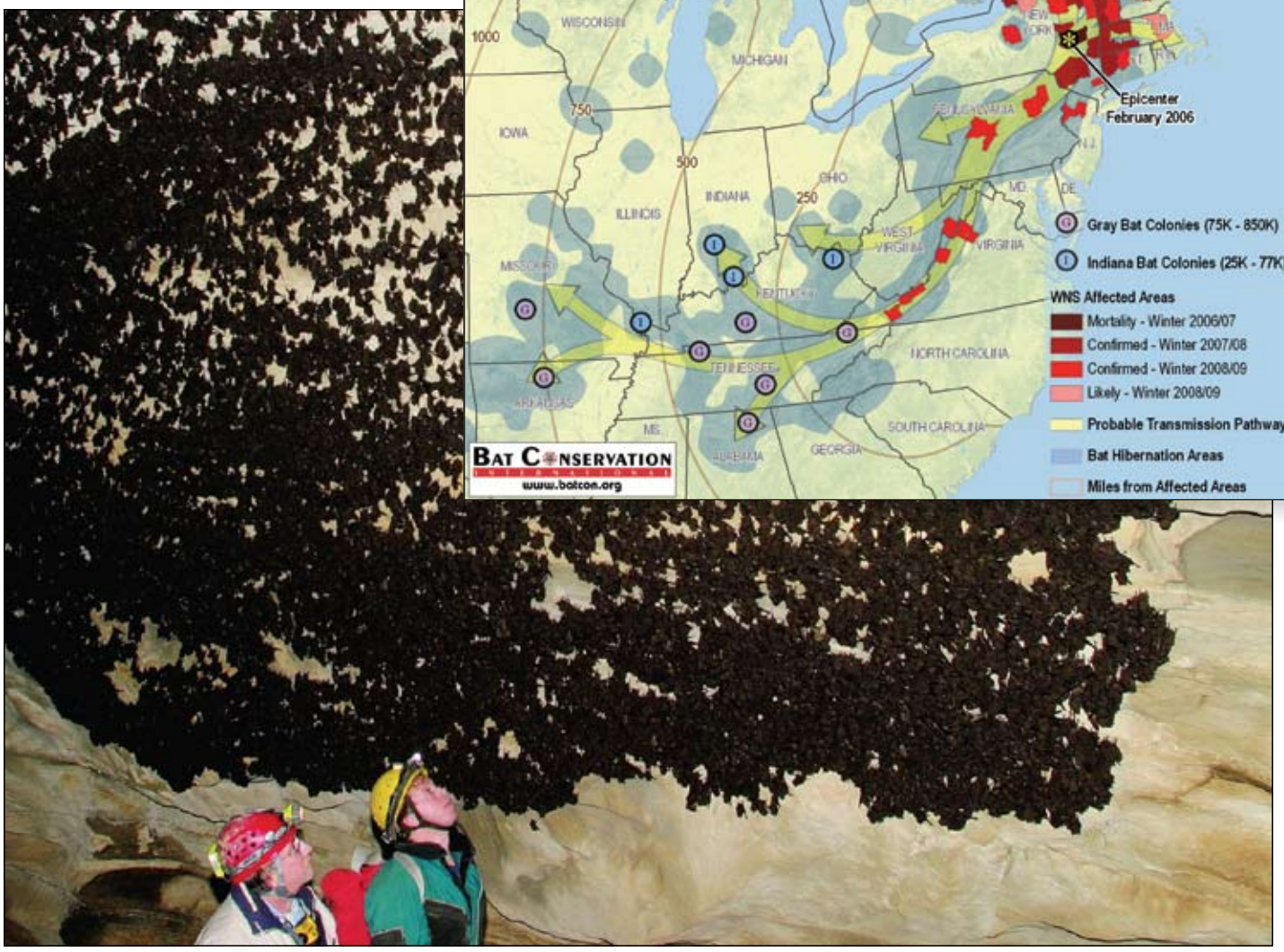
- Using ArcGIS, BCI created an integrated geodatabase of critical hibernation sites.
- BCI created maps based on georeferenced band recapture and radio telemetry studies.
- The maps have been widely distributed and were used in the congressional joint oversight hearing.

Caves have become graveyards for what biologists estimate as more than one million bats, the victims of a devastating disease known as white-nose syndrome (WNS).

Building on the work of its partners, Bat Conservation International (BCI) is using GIS to create a geodatabase of critical hibernation sites and map the probable spread of the disease. Understanding how WNS has spread and is expected to spread in the future will help biologists respond to the disease using surveillance and conservation actions.

The first case of WNS in hibernating bats was discovered in a cave near Albany, New York, in February 2006. Since then, the disease is known to have killed bats in Connecticut, Massachusetts, New Hampshire, New Jersey, Pennsylvania, Vermont, Virginia, and West Virginia.

Named after a cold-loving white fungus found on bats' muzzles and wings, WNS is linked to damage on wing membranes, excessive loss of limited fat reserves during winter, and death from starvation before spring. Since the disease was first discovered, WNS has spread rapidly across the eastern United States and affected six species of insect-eating bats (one of which, the Indiana bat, is federally endangered), causing mortality approaching 100 percent at some hibernation sites. The current losses are staggering, but biologists believe even larger numbers of bats and additional endangered species are at significant risk in the path of WNS.



Jim Kennedy of BCI (left) and Chester Martin observe a colony of gray bats (photo by Merlin D. Tuttle, BCI). Above: The future spread of WNS could impact the most important hibernation sites for the endangered Indiana and Gray bats. Map sources: Bat Conservation International, National Atlas, Natural Earth, North American Atlas, Ontario Ministry of Natural Resources, Pennsylvania Game Commission, U.S. Fish and Wildlife Service, and West Virginia Division of Natural Resources.

Why We Need to Protect Bats

BCI, a nonprofit organization based in Austin, Texas, is committed to conserving bats and their ecosystems through worldwide partnerships, research, management, education, and outreach. Most North American bat species feed on night-flying insect pests that impact forests, agriculture, and human health. Globally, bats provide countless millions of dollars of ecosystem services, including insect/pest management, pollination, seed dispersal, and growing ecotourism appeal. Bats exist in every biome on earth except the extreme Arctic and Antarctic regions and are vital to maintaining balance in ecosystems. More than 1,100 species of bats worldwide account for nearly 20 percent of all mammal species, yet they are poorly studied and often neglected in conservation planning, leaving many bat species endangered or threatened with extinction. Now bats face another threat, WNS, which is causing the most precipitous decline of North American wildlife in recorded history. Such losses alone are expected to have unprecedented consequences on ecosystem health throughout North America, with unknown economic consequences.

GIS—An Essential Tool for Understanding WNS

GIS technology is helping biologists better understand the spread of WNS. Spatial analysis of currently affected areas and potential future spread is necessary for focusing efforts to raise awareness and promote preparedness. For example, states within the path of WNS will likely develop WNS surveillance plans and adjust their budgets to plan for the cost of a WNS response. BCI has a long history of working with state and federal agencies planning bat conservation activities but has never had in-house GIS capabilities. A few past projects have focused on developing geospatial datasets, but no long-term plan was in place for establishing GIS as part of day-to-day operations. In October 2008, BCI applied for and received an ESRI conservation grant for ArcGIS software to support its new strategic plan to spatially enable the organization.

As WNS has progressed, Cal Butchkowski of the Pennsylvania Game Commission has used GIS to compile reports into a comprehensive map showing WNS-affected counties across the northeastern United States. Affected sites have been aggregated at the county level to protect sensitive cave and mine location information. Butchkowski's maps clearly show the spread of WNS across the landscape.

BCI's conservation mission led to additional questions about the future spread of WNS and the threat it posed. BCI became concerned that WNS could reach hibernation sites housing the largest numbers of endangered Indiana (*Myotis sodalis*) and gray (*Myotis grisescens*) bats in the United States, but the organization did not have the data necessary to visualize the potential risk. Colleagues at the Pennsylvania Game Commission, U.S. Fish and Wildlife Service, West Virginia Department of Natural Resources, and others, provided data on the hibernation sites that housed the largest numbers of endangered bats. Using ArcGIS, BCI created an integrated geodatabase of critical hibernation sites and mapped the probable routes of future transmission of WNS based on georeferenced band recapture and radio telemetry studies. The resultant maps of the spread of WNS—created entirely using ArcGIS Desktop software's ArcMap application—have been widely distributed and were used in the congressional joint oversight hearing on WNS held June 4, 2009, which focused on increasing awareness about the current status of WNS and threats posed by its future spread. The maps helped illustrate that WNS is no longer a regional issue but has quickly become a national crisis and has the potential to affect bats internationally. Based on the testimony of bat experts during the hearing, it became apparent that current funding for WNS research and monitoring is inadequate.

GIS capabilities at BCI enabled researchers to clearly articulate the urgency and ecological risk of WNS. GIS will also help BCI raise money to achieve its conservation mission. Geospatial data and maps have a growing value in securing funding for nonprofit conservation work. Proposal applications are often limited to one or two pages of narrative to capture the need and planned use of potential grants. The addition of maps allows BCI to convey the scope of the problem and work area at a glance without exceeding space constraints for the proposal text. The future opportunities GIS will bring to BCI are exciting, both to explore conservation issues and articulate BCI's mission.

About the Authors

Mylea Bayless is a conservation biologist who focuses on white-nose syndrome, southeastern rare bats, and bats in bridges. Zachary Wilson is an independent GIS consultant.

More Information

For more information, contact Mylea Bayless (e-mail: mbayless@batcon.org). BCI graciously acknowledges the support and investment of its many partners and funders—including the Beneficia Foundation, the Department of Defense Legacy Program, Disney's Rapid Response Fund, the Kabcenell Foundation, the National Fish and Wildlife Foundation, the National Park Service, the Nina Mason Pulliam Charitable Trust, the U.S. Fish and Wildlife Service, the U.S. Geological Survey, the Wallace Global Fund, ESRI, and other numerous state and federal agencies responsible for managing our nation's wildlife. The following links provide the latest information on white-nose syndrome: **www.batcon.org/wns**, **www.fws.gov/northeast/white_nose.html**, **www.nwhc.usgs.gov/disease_information/white-nose_syndrome**, and **www.fort.usgs.gov/WNS**.

Texas Students Use GIS to Track H1N1 Flu

Highlights

- Students created a basemap that joined the attribute table and spreadsheet by matching county names.
- Visualizing data on a map helped students analyze the data, promoting higher-level thinking skills.
- The students used their GIS skills to create a visual element relevant and meaningful to all of western Texas.

Last April, when the spread of H1N1 (swine) flu began, students in Texas watched with a vested interest. The Texas Education Agency made recommendations to reschedule or cancel area and state-level competitions in an effort to limit student travel and minimize contact. With events approaching, like prom, spring concerts, and even graduation ceremonies, students waited as local school districts made careful decisions. Some districts halted student travel and others canceled school classes for a period of weeks.

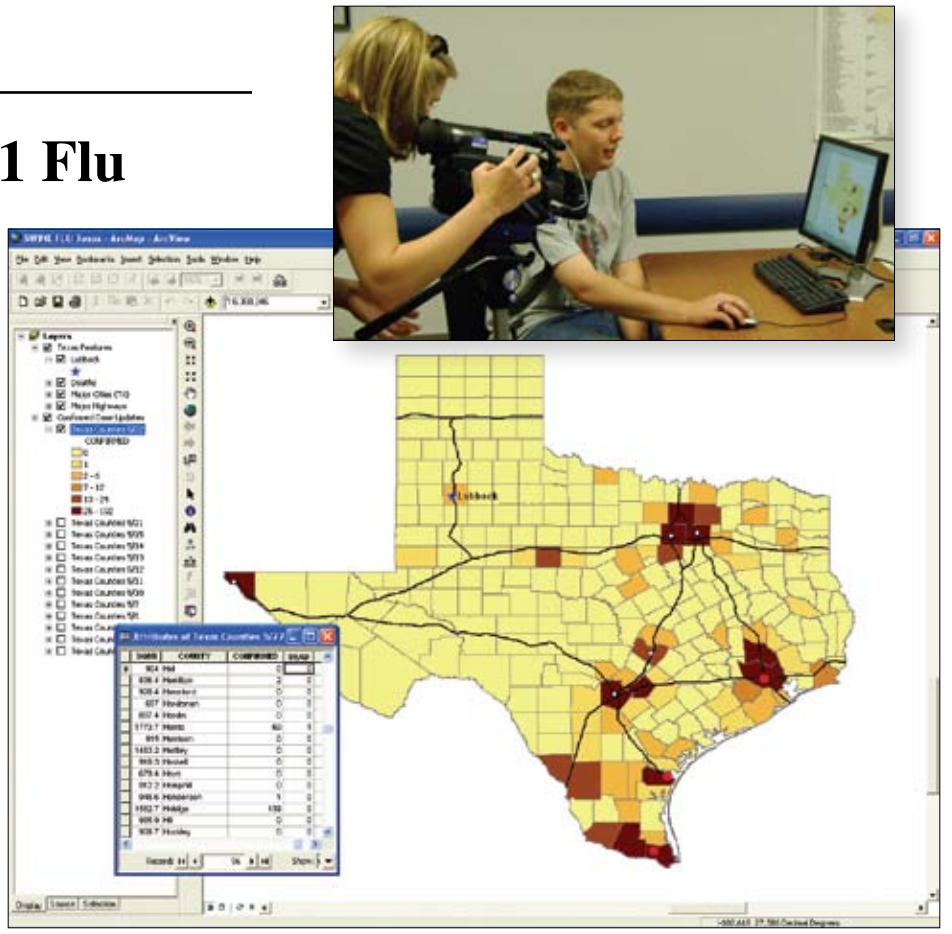
Lubbock Independent School District GIS teacher Penny Carpenter knew GIS tools would be used to monitor and inform the public of the flu's pandemic potential, and she saw a unique opportunity for her students. Philosophically, Carpenter motivates students with relevant real-world topics, and the reality of H1N1 flu had certainly captured her students' attention. They found maps of countries and states with confirmed flu cases but none of Texas counties. Because the outbreak originated in Mexico, students looked to the border towns for reported infections, and that is when geographic inquiry began: Where were the counties in Texas with confirmed H1N1 flu cases?

The Texas Department of Health's Web site posted a confirmed case count by county and provided daily updates. Students created a list of Texas counties in a spreadsheet and entered the data of confirmed cases. Next, students used the school's ArcGIS Desktop ArcMap application to create a basemap of Texas counties. They joined the map's attribute table to the spreadsheet data by matching county names. After discussing appropriate breaks for the data range, the quantities of confirmed cases were mapped using graduated colors.

During the initial analysis, students discovered the darkest colors, representing the highest number of confirmed cases, appeared in the heavily populated areas, not the border counties. They discussed common aspects these areas shared that could explain the flu's spread. In the GIS, students added a layer of roadways and airports for comparison. Although each major area had a large airport, all areas were connected with major highways. This analysis supported the theory that travel by car was more likely to explain and continue the spread.

Students continued to update the data over the next several days and watched the flu spread along the roadways. Confirmed cases colored counties on the map moving west on Interstate 20, the major highway that connects Lubbock to the rest of the state via Highway 84. On the last day of school, the first confirmed case for Lubbock County was announced. The local television station broke the story and featured the work of Carpenter's students. Their GIS skills created a visual element that was relevant and meaningful to all of western Texas.

Student Tyler Funk explains, "I'm just in awe that I can build the maps in GIS to help other people understand the data and how it affects them." Funk now contemplates areas of study that will develop his ability to construct datasets and analyze them through graphic representation. Carpenter believes she teaches more than building maps. "When students can visualize and see the data on a map, they begin to analyze, and this promotes higher-level thinking skills," she says.



Students join flu data from a spreadsheet to the Texas counties attribute table to symbolize the case counts with graduated colors. In addition, data containing major highways, large cities, and locations of H1N1 flu deaths were layered. Inset: KCBD TV reporter Ann Wyatt films Tyler Funk as he uses ArcGIS Desktop to animate the spread of H1N1 flu in Texas counties.

More Information

For more information, contact Penny Carpenter, GIS teacher, Byron Martin Advanced Technology Center, Lubbock Independent School District (tel.: 806-773-6918, e-mail: pcarpenter@lubbockisd.org).

About the Program

Penny Carpenter teaches *Geographic Information Systems and Global Positioning Systems (GIS/GPS),* an innovative course she proposed that was approved by the Texas Education Agency. It is one of many skill-based or career and technology education courses offered at her campus, the Byron Martin Advanced Technology Center (ATC). Courses are available at the ATC to all students from the four high schools within the Lubbock Independent School District. These weighted credit electives require no special application process, and many allow students to earn technical preparation or dual college credit. These courses promote career skills, and some provide opportunities for students to earn industry-recognized certifications. Career and technology education courses like GIS/GPS provide students with a pathway to the workforce and/or higher education.

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Dynamic Topographic Basemap Production

Enterprise Product on Demand Technology Significantly Improves Efficiency for U.S. Forest Service

ESRI Services

Highlights

- GIS helps USFS reduce basemap revision cycle.
- USFS users can generate maps on the fly with custom quad extents.
- The new system eliminates dependence on film-based map printing.

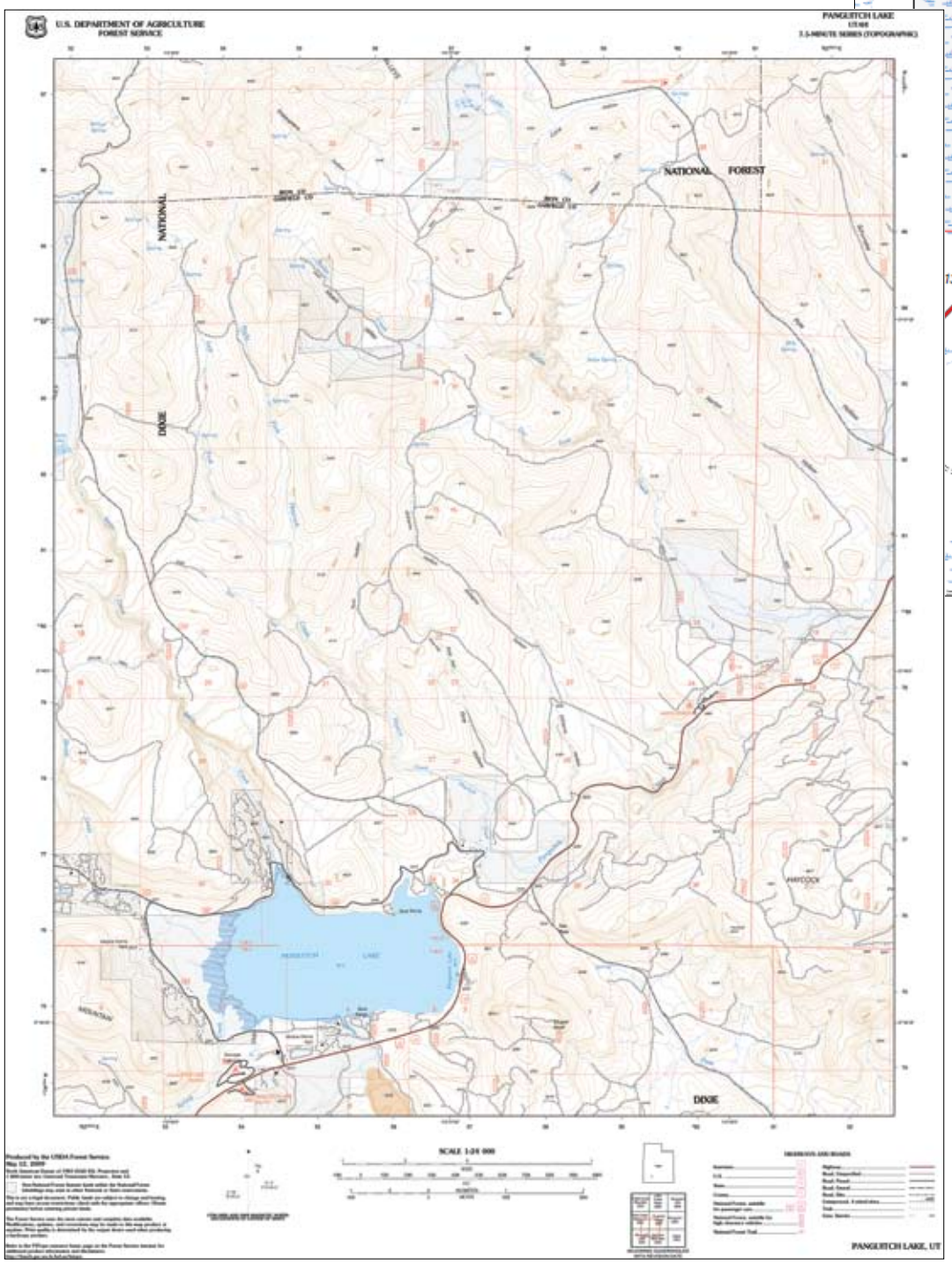
The U.S. Forest Service (USFS) was established in 1905 as an agency of the United States Department of Agriculture (USDA) with the mission "to provide the greatest amount of good for the greatest amount of people in the long run," according to Gifford Pinchot, its first chief. Today, USFS operates through nine geographic regions and manages 193 million acres of the United States' national forests and grasslands.

The USFS Geospatial Service and Technology Center (GSTC) is responsible for producing and disseminating geospatial data as well as providing a wide range of technical support services to the USFS. GSTC directly supports mission-critical activities, such as forest planning, recreation, habitat modeling, forest health protection, resource inventory management, transportation management, and fire planning and response.

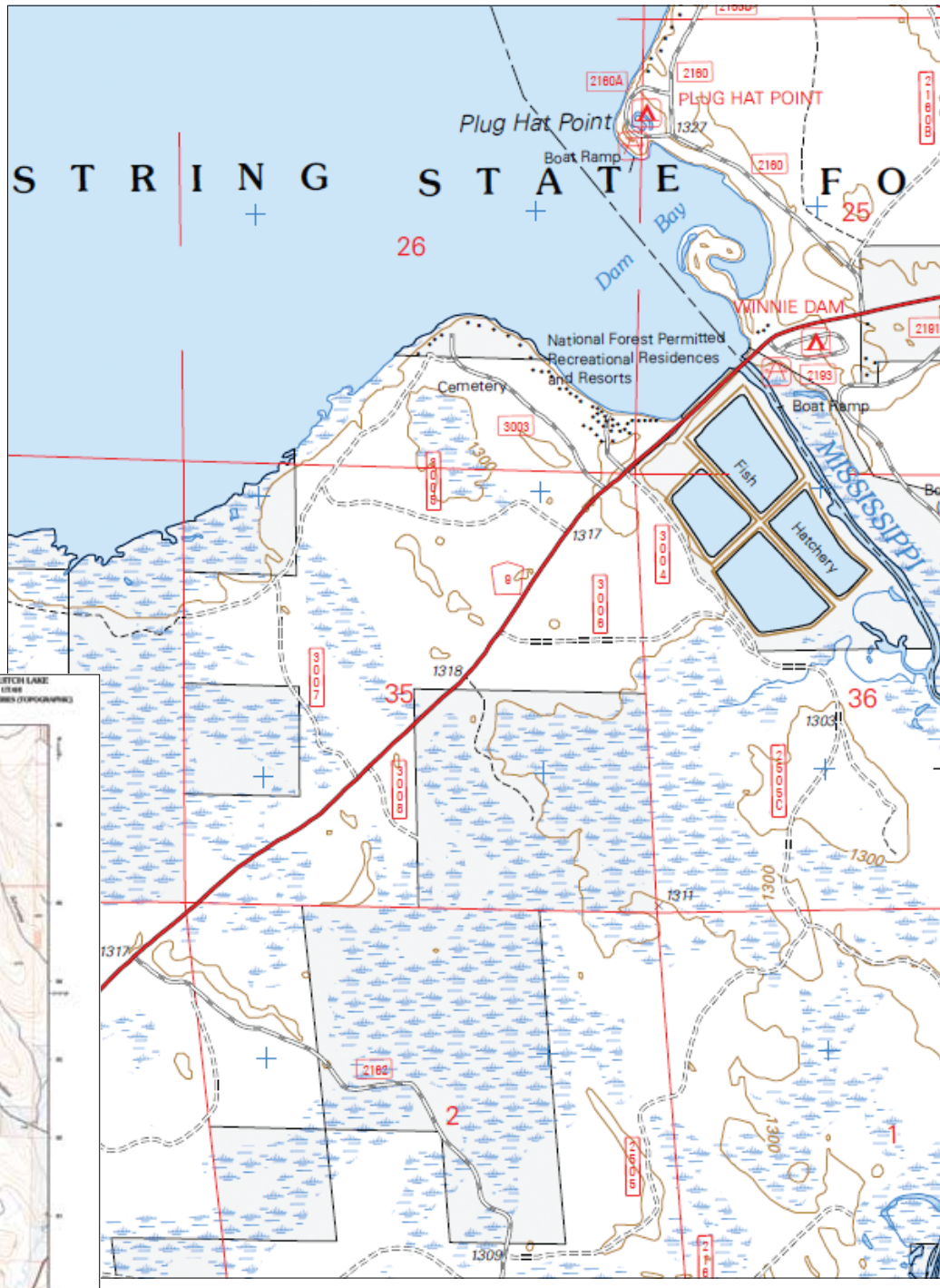
The Challenge: Improving Map Production Efficiency

GSTC manages the production and maintenance of basemap products covering the lands managed by the USFS. These products include 1:24,000- and (in Alaska) 1:63,360-scale topographic maps. In the contiguous 48 states, the map extent is 7 1/2 minutes by 7 1/2 minutes. In Alaska, the map extent is either 15 minutes by 20 minutes or 15 minutes by 22 1/2 minutes. The extent of each map is known as a quadrangle, or quad. GSTC manages more than 10,600 quads.

Historically, any revision of a quad required generating five film-based color separation layers. Over the years, map revision has become increasingly expensive using this process. Making very minor revisions was cost prohibitive. In addition, it took over 10 years for a specific quad to be scheduled into GSTC's map revision program and then revised.



Sample map produced using the FSTopo System.



The Solution: Enterprise Product on Demand Technology

GSTC, through its close association with ESRI Professional Services, learned of ESRI's successful implementation of its Enterprise Product on Demand Service (ePODS) for the National Geospatial-Intelligence Agency (NGA).

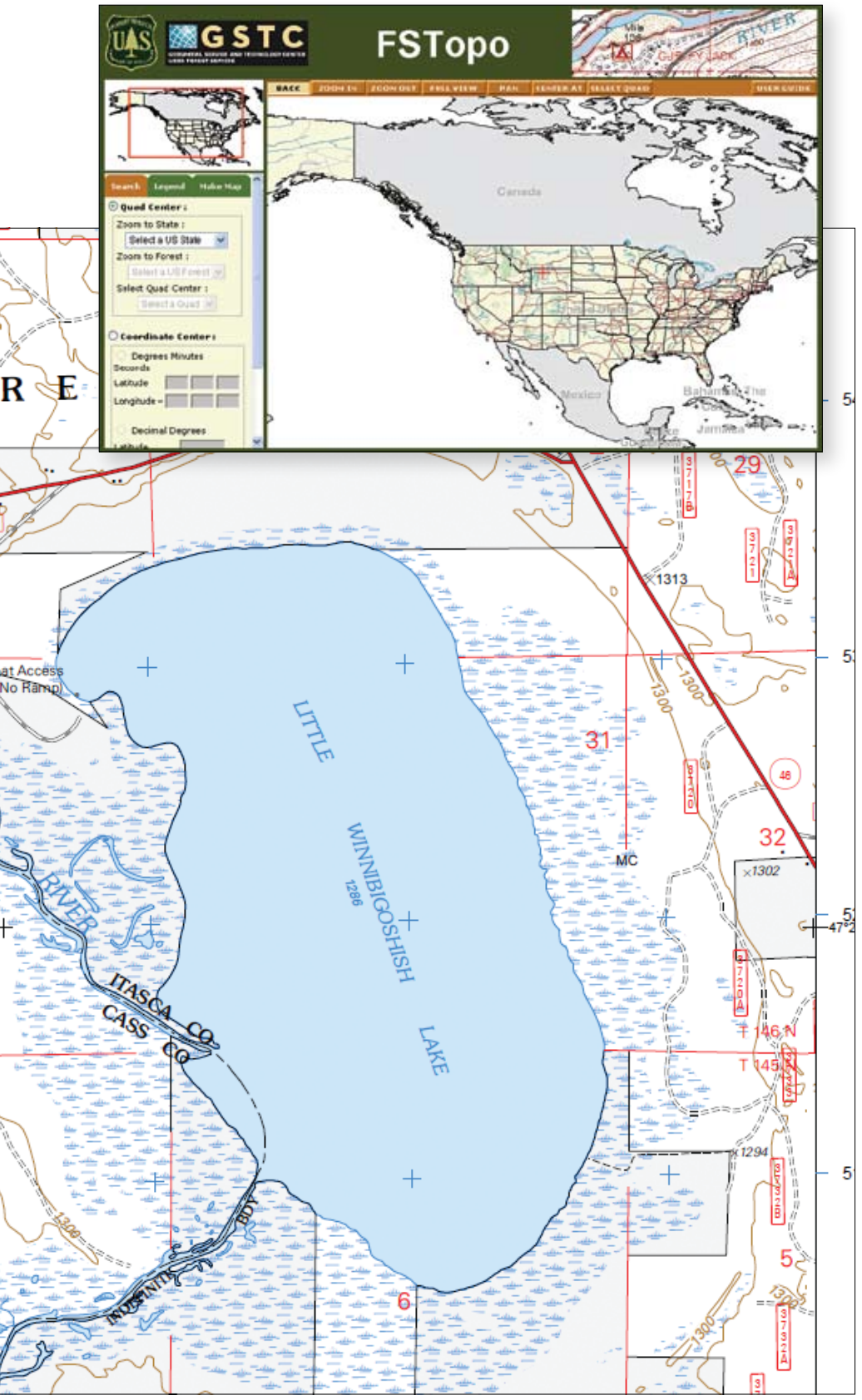
Byron Taylor, GSTC project manager, says, "Knowing that the product had been successfully implemented at NGA was important as we considered the risks common to technology integration and analyzed the technology against Forest Service business requirements."

GSTC then contracted with ESRI Professional Services to create a similar approach tailored to meet USFS needs—FSTopo. FSTopo is database driven and enables on-the-fly generation and downloading of large-scale topographic maps. The Web-based user interface allows users to browse and select data, then produce the desired map.

The FSTopo system was built on service-oriented architecture using ESRI commercial off-the-shelf software. ArcGIS Server and ArcIMS provide the GIS Web services and portal functionality, respectively. The Web portal lets users access FSTopo anytime from any USFS computer.

The project team migrated GSTC's cartographic database to a geodatabase schema comprising descriptive subtypes and coded value domains. Once the database was populated, map template documents were constructed. The templates included static and dynamic margin elements.

While, traditionally, GSTC has produced these maps according to a standard, static quad extent, users can now choose a custom quad



ArcSDE database-driven symbology via ArcGIS Server Map Service. Top: FSTopo ArcIMS user interface.

extent by selecting their own map centerpoint. This allows them to generate maps for user-specified areas of interest. The custom extent is displayed relative to the standard extent in a diagram in the margin. The declination diagram, showing the relationship between magnetic and true north, is generated according to the centerpoint selected by the user. The deliverable is a map in Adobe PDF, which the user can save, print, or plot. FSTopo maps use feature symbology that has been designated or designed according to product standards. Map marginalia are generated on the fly.

Reduce Map Production Time and Increase Efficiency

Since the launch of FSTopo in June 2007, GSTC has achieved significant improvements in map production efficiency. Karen Nabity, GSTC map production expert working on the project team, reports, "By adapting the product on demand technology to meet our production requirements, we are able to get minor changes to the customer much faster." Now that edits are not subject to the film-based workflow, the turnaround time for minor revisions has been notably reduced from over 10 years to approximately 3–6 months. In addition, the costs and overhead associated with film-based printing have been eliminated. The FSTopo site provides 365/24/7 access to USFS users.

"FSTopo is key to our success as we leverage current technology to reduce map production costs and get more current information into the hands of users more quickly," says Nabity.

More Information

For more information, contact Byron Taylor, GSTC project manager, USFS (e-mail: btaylor01@fs.fed.us, tel.: 801-975-3447), or Shree Rajagopalan, ESRI (e-mail: srajagopalan@esri.com; tel.: 909-793-2853, ext. 4327).

Zeroing In on Natural Resources

GIS for Customizing Earth Sciences Applications

Highlights

- Lineament maps uncover new patterns in the earth's surface never before documented on geological maps.
- GIS helps increase the success rate of costly drilling activities in search of oil and gas.
- Geologists can analyze data from two to four kilometers beneath the earth's surface.

Hydrocarbon exploration is an expensive, high-risk operation that involves searching for hydrocarbon deposits (like oil and gas) beneath the earth's surface. Though visible surface features can provide evidence of hydrocarbon generation, most exploration methods depend on highly sophisticated technology to detect and determine the presence of these deposits deep within the earth.

In early 2000, there was a significant natural gas discovery in southern New York that led to a boom in hydrocarbon exploration. Shortly after this discovery, MIR Télédétection Inc.—a natural resources consulting firm located in Québec, Canada,—began providing expertise to help target hydrocarbon reservoirs.

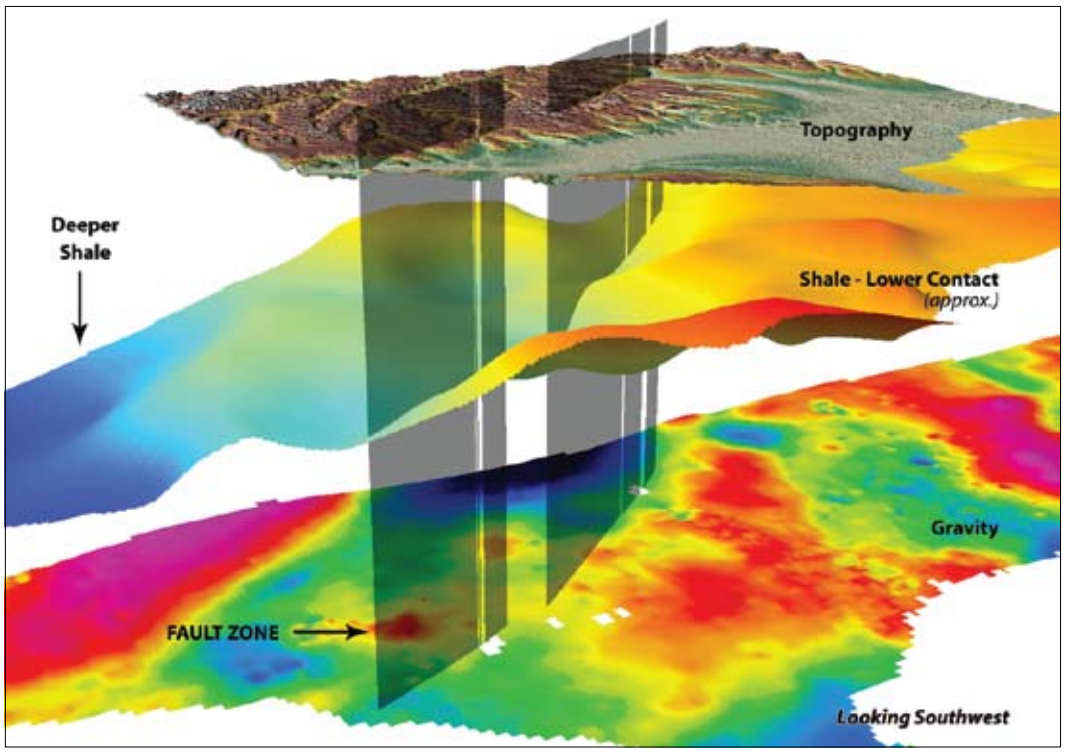
Among the many services MIR provides are customized earth sciences applications that support hydrocarbon exploration in North America through the capture, integration, and analysis of geologic, remotely sensed, and geoscientific data. Its research plays an integral role in successfully turning leads (structures that may contain or trap hydrocarbons) into prospects (leads that have been fully evaluated and are ready to drill).

Through the support of the New York State Energy Research and Development Authority (NYSERDA), MIR developed an integrated approach to hydrocarbon exploration for the southern part of New York. The model leverages ArcGIS and the ArcGIS 3D Analyst extension to structurally analyze surface and subsurface data and target promising areas for exploration. This analysis optimizes the planning of costly seismic surveys—a process by which sound waves are used to create a profile of an area's substructure. Once a seismic survey has been completed and a prospect identified, exploration wells are drilled to conclusively determine the presence or absence of oil or gas.

MIR built its hydrocarbon exploration model by customizing an in-house process to effectively merge surface and subsurface data. A variety of data sources was incorporated to analyze the earth's surface, including Landsat satellite imagery that offers a multitemporal, multispectral, and multiresolution range of imagery ideal for land-cover analysis. It also incorporated a digital elevation model (DEM) that shows landform arrangements associated with subsurface geologic features. The datasets were orthorectified, mosaicked, and processed through shaded relief techniques to create a detailed representation of the earth's land cover.

Airborne magnetic data sources that monitor variations in the earth's magnetic field were then integrated, along with gravimetric data (surface point measurements), to analyze the earth's substructure and identify deep source basement fault geometry (rocks that exist below younger sedimentary rocks). By integrating these data sources, MIR geologists could create subsurface layers and study data from two to four kilometers beneath the earth's surface. Using ArcGIS 3D Analyst, MIR was able to achieve a three-dimensional view of the hydrocarbon exploration model, showing spatial relationships between surface landform patterns and deep subsurface fault zones (which refer to rock fractures), along with their potential control on sediment deposition.

ArcGIS was leveraged to represent the data in a series of lineament maps that highlighted fracture patterns on the earth's surface. Geologists used filtering methods to highlight specific features of interest (or leads) that would serve as target areas for detailed seismic surveys. By linking this information to subsurface data, the geologists were able to identify connections between the earth's land cover and fractures deep within the earth's crust that date back more than a billion years.



A 3D snapshot of the hydrocarbon exploration model (shale-lower contact data source: New York State Museum).

"The extension provided a simple method for viewing surface and subsurface data so that we could easily identify correlations between surface lineament corridors and subsurface geophysical discontinuities," says Michel Rheault, president, MIR. "We were then able to extrapolate the surface geologic interpretation and propose new fault zones that may contribute to reservoir generation or trap hydrocarbons deep within the earth."

MIR's structural maps uncovered new patterns in the earth's surface that had never been identified on existing geologic maps. For example, piles of flat-lying rock units were sculpted by rivers, resulting in valleys that had previously been mistaken for surface fractures. According to MIR's research, these fractures likely extend deep down beneath the surface and crosscut porous rocks—information that is critical to hydrocarbon exploration. These new lineament-based structural maps are leveraged to optimize seismic survey planning and increase the success rate of costly drilling activities in New York and the province of Québec.

More Information

For more information, contact Michel Rheault, MIR Télédétection Inc. (e-mail: mrheault@mirteledetection.com; tel.: 450-651-1104, ext. 22; Web: **www.mirteledetection.com**).

USGS History, Part 2:
From the Dawn of Digital to **The National Map**

125 Years of Topographic Mapping

By E. Lynn Usery, Dalia Varanka, and Michael P. Finn, U.S. Geological Survey

See Part 1 on the cover page of the Fall 2009 issue of *ArcNews*.

The United States Geological Survey (USGS) entered the mainstream of developments in computer-assisted technology for mapping during the 1970s. The introduction by USGS of digital line graphs (DLGs), digital elevation models (DEMs), and land use data analysis (LUDA) nationwide land-cover data provided a base for the rapid expansion of the use of GIS in the 1980s. Whereas USGS had developed the topologically structured DLG data and the Geographic Information Retrieval and Analysis System (GIRAS) for land-cover data, the Map Overlay Statistical System (MOSS), a nontopologically structured GIS software package developed by Autometric, Inc., under contract to the U.S. Fish and Wildlife Service, dominated the use of GIS by federal agencies in the 1970s. Thus, USGS data was used in MOSS, but the topological structure, which later became a requirement for GIS vector datasets, was not used in early GIS applications. The introduction of ESRI's ARC/INFO in 1982 changed that, and by the end of the 1980s, topological structure for vector data was essential, and ARC/INFO was the dominant GIS software package used by federal agencies.

USGS production of the first map series designed specifically for the computer era began in the mid-1970s. USGS designed completely new symbology with solid continuous lines and colors suited for automatic scanning and reproduction with computer technology for the 1:100,000-scale topographic maps. The entire series, more than 1,800 maps, was completed in the 1970s and 1980s. In preparation for the 1990 Census, USGS converted transportation and hydrography from the 1:100,000-scale maps to DLG data.

The conversion process required photographic transfer of the transportation and hydrography line work from film negatives to special polyester film sheets. The polyester film sheets were then highlighted with specific colors in special inks to identify potential problems in the digital conversion process. The polyester film sheets were then scanned at 1,200 dots per inch on a raster drum scanner from Scitex. The scanned data was automatically processed to thin the raster lines to single pixel widths, convert them to vector lines, and build topological structure. During the vectorizing process, the Scitex editing software was set to automatically find the special inks used to mark potential trouble areas for the vectorizing algorithm. After the vectorizing and topological structure construction were complete, the data was transferred to the Census Bureau for additional attribution and entry as part of the Topologically Integrated Geographic Encoding and Referencing (TIGER) line files for the 1990 Census.

Production automation had begun in the 1970s with the development of the Digital Cartographic Software System (DCASS) for photogrammetric compilation and the Graphic Map Production System (GRAMPS) for cartographic editing, leading to the release of the first digitally produced map in a provisional format—of Birch Tree, Missouri—in 1983. During the 1980s, USGS continued its innovative role with developments in DEM and orthophoto production capabilities. From 1974 to 1983, USGS conducted research on the Aerial Profiling of Terrain System (APTS) for measuring stream-valley cross sections and profiles, older map reliability testing, and producing control for topographic maps. The system consisted of an inertial measuring unit (IMU), a laser tracker, a laser profiler, a video-imaging system, supporting electronics, and a computer. Data generated by the system included the laser returns to generate elevations and the video images. This system was a precursor to the lidar systems of today.

In 1987, USGS introduced the concept of the digital orthophoto quadrangle (DOQ), using digital scanning of photographic stereo pairs and processing software to create a digital image with correct map geometry. Following the introduction, USGS, in cooperation with the U.S. Department of Agriculture (USDA), generated digital orthophotos at one-meter resolution for the 48 contiguous states of the United States. The DOQ of USGS became the standard base image for many geographic information systems in the 1990s. USGS and other federal agencies continue to acquire new DOQ coverage of the United States every few years, building to complete repetitive coverage with the Imagery for the Nation (IFTN) program.

USGS began data model development for computer-assisted cartography and GIS in the 1970s with GIRAS, DLG, and DCASS. The development of the Federal Geographic Exchange Format (FGEF) in the late 1970s was the beginning of standardization of data models and formats for geographic information and led to the establishment of the Spatial Data Transfer Standard (SDTS), which was adopted by the International Organization for Standardization in the 1990s. SDTS libraries supporting import and export of data to and from SDTS were developed and made available to the public by USGS. Many GIS vendors incorporated these libraries into their code packages. Simultaneous to development of SDTS, USGS developed the digital line graph—enhanced (DLG-E), a feature-based GIS data model released in 1990. Further refinements of DLG-E led to DLG—feature (DLG-F) and, finally, to the feature-based data model currently used in the National Hydrography Dataset (NHD). Whereas the DLG-E and DLG-F models were not incorporated directly into software for GIS, during the next 15 years, the feature-based ideas pioneered by USGS became standard in the GIS industry.

In 1991, USGS completed the analog map coverage of the 48 contiguous states of the United States at 1:24,000 scale. The coverage includes more than 55,000 7.5-minute quadrangles. While completing the production of the 7.5-minute series of the National Mapping Program and continuing its revision, USGS also continued its developments of digital databases for cartography and GIS. After the completion of United States coverage with 7.5-minute, 1:24,000-scale topographic maps, USGS contracted to have the most recent editions of the maps converted to digital raster graphics (DRGs). The DRGs were geocoded and became a critical layer in GIS, useful for image rectification, feature extraction, and other applications.

In the 1990s, USGS moved from quadrangle areas, usually constructed from 7.5-minute, 15-minute, 30-minute, or 1-degree areas to seamless nationwide layer-based datasets. The first of these completed was the National Elevation Dataset (NED), a multiresolution, seamless, nationwide mosaic of elevations created from

The new USTopo product includes hydrography, geographic names, elevation contours, and orthophotos.

existing USGS databases of 7.5-minute tiles with 30-meter horizontal spacing, 7-meter root mean square error (RMSE), 1-degree tiles with 3-arc-second horizontal spacing, and a vertical 30-meter RMSE. USGS has continued to improve the NED with elevations on a 10-meter horizontal spacing that is now available for the conterminous 48 states and, most recently, with lidar data, generating elevations on a 3-meter horizontal spacing.

USGS also began to construct the National Hydrography Dataset (NHD) in the 1990s. The NHD incorporates the concept of geographic features in the form of reaches of streams and other geographic entities to represent surface water. In association with the Environmental Protection Agency (EPA) and many state organizations, USGS embarked on a new system of data maintenance and update with the NHD using a system of stewardship. This system is now becoming a model for other data maintenance agreements.

The National Land Cover Dataset was created as a seamless mosaic of 21 land-cover categories from Landsat Thematic Mapper (TM) images from 1991 to 1992. This 30-meter resolution dataset was released in 2001; a second coverage for the United States was released in 2008 from 2001 TM images. Seamless land cover for the United States provides a base for many scientific applications and is one of the most frequently downloaded of the USGS datasets.

In 2001, USGS released its vision for the topographic map of the 21st century: *The National Map*—a seamless, continuously maintained, nationally consistent set of base geographic data. A collaborative effort to improve and deliver topographic information for the nation, *The National Map* consists of eight data layers: transportation, hydrography, boundaries, structures, geographic names, land cover, elevation, and orthographic images. The goal of *The National Map* is to become the nation's source for trusted, nationally consistent, integrated, and current topographic information available online for a broad range of uses. The seamless databases constructed in the 1990s and early 2000s became the base data for *The National Map,* with additional data from federal, state, local, and tribal sources being continually added.

In 2009, USGS defined the graphic output to be generated and distributed from *The National Map* as a GeoPDF of the eight data layers. The initial release, known as Digital Map—Beta, included an orthographic image based on photography from the National Agricultural Imagery Program (NAIP), transportation data of interstate and U.S. highways from the Census Bureau, geographic names from the Geographic Names Information System, a United States National Grid shown on 1,000-meter grid lines, and the metadata contained in the map border and collar information. Beginning in October 2009, contours and hydrography were added to the new map, which was renamed USTopo. The remaining layers of *The National Map* will be added to USTopo in 2011. The NAIP photography acquires complete coverage of the 48 contiguous states every three years; thus, USGS will generate new topographic maps every three years to follow the NAIP cycle.

In surveying, photogrammetry, and cartography, USGS innovations have led or enhanced developments in the broader fields of mapping and GIS. USGS developed agreements for local applications and provided data for land and science management needs. This history of accomplishment forms the basis for future innovations for growth of the industry.

About the Authors

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Michael P. Finn holds a B.S. in geography with a minor in cartography and map technology from Southwest Missouri State University (now Missouri State University) and an M.S. in civil engineering from Virginia Polytechnic Institute & State University. He has worked as a computer and IT specialist and a research cartographer with the USGS for the past 10 years.

More Information

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How to Prepare for and What to Expect at the ESRI International User Conference

Hear What a New Attendee and a GIS Journalist Have to Say About the ESRI UC

ESRI president Jack Dangermond presenting at ESRI UC.

While ESRI begins planning for the 2010 ESRI International User Conference (ESRI UC)—being held in San Diego, California—GIS users worldwide are also beginning to make their own plans for justifying the trip, scheduling their time at the conference, and arranging travel to and from the venue. To help users in this process, ESRI has asked a user and a GIS journalist to author a few words about what it's like to attend the conference, from valuable benefits and personal favorites to tips and tricks when creating a customized agenda. Contributor Nancy Johnson Sanquist is an International Facility Management Association (IFMA) fellow and vice president of Manhattan Software in Milford, Massachusetts. She attended the ESRI UC for the first time in 2009. Contributor Glenn Letham is a cofounder and managing editor of GISuser.com. He's a 10-year conference veteran.

Nancy Johnson Sanquist, Vice President of Manhattan Software, International Facility Management Association Fellow

I've been in the field of facility management and corporate real estate technology for the past 25 years and have attended hundreds of professional conferences for my industry all over the world. None of this prepared me for anything like the ESRI UC.

Most conferences have one keynote speaker who is usually a motivational celebrity or the latest business writer/guru/futurist not necessarily related to the work of the attendees. The ESRI UC Plenary Session offered a virtual parade of well-known people explaining how GIS helped them do important work in the world.

I can't recall attending another conference where I've seen awards presented, not just to a "super user" of a product, but also to users who happen to be the governor of Maryland (whose GIS implementation is being copied by other states) and a world-leading economist designing new property rights systems for the world's urban poor, using GIS to unlock a trillion dollars of dead capital in untitled assets.

Hearing Maryland governor Martin O'Malley's story of applying GIS for crime prevention in Baltimore and then for the entire system of state government and Hernando de Soto's description of a pilot project in Ghana using geospatial technologies to create a land titling process and land records system were truly inspirational to me and, I suspect, to most of the thousands of people in the plenary.

And this was only the tip of the iceberg. The Special Displays area and Map Gallery, Exhibit Hall, and informative industry sessions all help a first-time attendee like me really want to be part of the ESRI community.

While the implementation that my company, Manhattan Software, has designed to integrate our real estate asset management system with the ESRI Business Analyst application may not be as showstopping as what these keynote speakers are doing, we do believe we're going to change the way many corporations all over the world visualize, collaborate, and make financial decisions on their real estate portfolios.

We've just begun to explore and consider all the possibilities this solution offers; I suspect we can't even imagine where these integration initiatives will take us. Attending the User Conference exposed us to literally hundreds of ideas we hadn't thought about before. It was a very energizing and useful experience.

More Information

For more information, contact Nancy Johnson Sanquist, Manhattan Software (e-mail: nsanquist@manhattansoftware.com, tel.: 858-699-0827).

Glenn Letham, Cofounder and Managing Editor of GISuser.com

The ESRI UC means many different things, depending on who you talk to. To some, it's an educational event; to others, a business retreat. Some are there with family members for a week in sunny San Diego (with a little geobusiness thrown in), many are attracted to the conference for the social activities, and others just want a chance to hear directly from ESRI president and founder Jack Dangermond about the direction of the company and new GIS solutions. There's no question, though, that the ESRI UC is the geotechnology event of the year, and to have a successful conference, I'm a firm believer that preconference planning and calendar preparation are crucial to get maximum return on investment from the event. There are also a few things during the conference that I feel an attendee must do.

For me, preconference planning involves the filling in of a calendar and a detailed once- or twice-over of the conference agenda, mainly to ensure that I get to all the sessions that are important to me. I also typically write one or two pre-event articles using a "What's Coming" or "What's Hot" theme—this really helps me prepare. You might wish to do so as well and share with your coworkers for feedback or trip justification.

Finally, in typical top 10 fashion, I'll share with you 10 other important things I try to do each year to ensure that I have a productive and enjoyable user conference experience:

1. I plan on arriving the Sunday of conference week to ensure that I'm rested and ready for business on Monday morning when the event kicks off. Sunday is a great day to meet up with old friends and find new ones. Last year, I attended a preconference seminar this day too.
2. For any first-time attendees, I definitely suggest trying to spend some time at the convention center on Sunday so you can get a lay of the land and prepare yourself for the week. ESRI offers a new attendee orientation, which is also highly suggested.
3. I "tweet it up" in the Gaslamp Quarter, the swank entertainment- and eatery-filled area surrounding the convention center.
4. I always plan to spend the entire first day (Monday) in the Plenary Session, where Jack has the stage for most of the day (all morning, at least), and when it's not Jack, it's a high-level product or industry manager, key business partner, or customer sharing interesting success story details. Stay in the main hall all day!
5. My favorite place to see and hear directly from users is the Map Gallery, where hundreds of maps are displayed and many of the authors are on hand to answer questions or just chat. Application developers are also provided with a forum to show off in the User Software Applications Fair—another great place to meet and mingle.
6. For me, connecting with ESRI product managers is invaluable. Any presentation that has the phrase "What's new" in it is a target for me, as this is typically where you get a chance to hear straight from the ESRI managers charged with the product's direction.
7. Times are tough, and you may need a little help. To minimize costs associated with a week in San Diego, early planning is a must and will save loads of money. Book everything early and take advantage of the participating conference hotels for great deals, but act fast! Community resources like Twitter, Facebook, and LinkedIn groups are also great resources where you can connect with other attendees and even locate someone willing to share accommodations with you to defer some costs.
8. For anyone whose boss may be on the fence about sending employees, consider creating a justification letter explaining why you should be considered to go. I always go through some form of cost/benefit discussion prior to committing, and I've been 10 years in a row.
9. If you can pull it off, consider bringing the family along. There are a number of family-friendly events planned throughout the week. Last year was my son's first conference, and he's already bugging me about next year. His highlights were the Exhibit Hall Family Night—seeing all the cool technology—and naturally, the fabulous Thursday Night Party.
10. Socialize. There are plenty of educational opportunities and chances to get your hands dirty with new technology; however, there are also an amazing number of social events and opportunities to hang out and talk shop if you like. When official ESRI social events aren't taking place, you'll find me at a Special Interest Group (SIG) meet-up (like Canada Night) or a vendor/business partner-hosted social. Most partners will have details of their planned parties at their booths on the exhibition hall floor.

The ESRI UC conference week is long, but it will go fast. Plan ahead accordingly and make the most of every hour while you're there. It may sound corny and a little daunting, but if you get a chance to take part in an ESRI UC, try to do it all. You'll be glad you did. You can always rest on the flight home.

More Information

For more information, contact Glenn Letham (e-mail: glenn@gisuser.com, Twitter: @gletham).

2010 ESRI International User Conference

The 30th annual ESRI International User Conference (ESRI UC) will take place July 12–16, 2010, at the San Diego Convention Center in California. While planning for the world's premier geospatial conference gets under way, ESRI users have a few things they can do to prepare to attend and get involved in the event.

Attendee Action Items and Deadlines

- Conference registration is now available online.
- January 11—Hotel rooms can also be booked online for a special rate starting January 11. Staying in downtown San Diego at a participating conference hotel offers the most value and convenience when it comes to travel, amenities, and attending event sessions and activities. (Special rates are not guaranteed after June 10.)
- March 19—Lightning talks were new to the ESRI UC in 2009. These are clear, quick, informal user presentations given in five minutes or less. The submission deadline is March 19.
- March 19—Visitors can also host Special Interest Group (SIG) and Regional User Group (RUG) meetings, which are ideal for collaborating with peers of the same interest, industry, or region. The request deadline is March 19.
- March 26—The Academic GIS Program Fair is an opportunity for representatives from higher education GIS programs to discuss their offerings with attendees, touch base with alumni, and meet students from the Student Assistantship Program. The application deadline is March 26.
- May 28—Attendees can also play an important part in the conference in a variety of ways. Users can have their GIS work showcased during the Plenary Session. Videos, screen shots, and images from the user community will be woven into ESRI president Jack Dangermond's opening presentation. The deadline for submissions is May 28.
- June 14—The conference Map Gallery and Virtual Map Gallery are a collection of paper and digital maps that illustrate how GIS adds value to organizations worldwide. The submission deadline is June 14.

Online Conference Community

Users can also be part of the online conference community. The event conversation can be followed on Twitter: @ESRIUC and with the hashtag #esriuc. Attendees can connect on the Official ESRI UC Facebook page. The UC Insider blog offers event news, tips, and reviews, and photos can be shared by searching Flickr for the esriuc tag. Also, notes from all the online community forums can be viewed by looking at or subscribing to any of the RSS feeds.

More Information

This conference is for all ESRI GIS users. To learn more about the 2010 ESRI UC, visit **www.esri.com/uc**. Registration, room reservations, and participation information can also be found at **www.esri.com/uc**.

New Green Roof at ESRI Canada

At its Toronto headquarters, ESRI Canada Limited, ESRI's international distributor in Canada, recently unveiled a new "green" roof expected to provide business and environmental benefits. The original paved terrace roof was transformed into an urban oasis that will help mitigate heat and provide additional habitat for birds, butterflies, and other wildlife. The outdoor space can now be used for formal office meetings, corporate events, and informal lunch breaks.

"We commend companies such as ESRI Canada for their important contribution and continued focus on environmental sustainability," says City of Toronto mayor David Miller. "With the addition of this new green roof, we have taken another step in making Toronto a healthy and livable city."

The green roof will provide energy savings by reducing heating and cooling costs, as plant layers insulate the building and temper the air. Additionally, the green roof retains up to 75 percent of summertime precipitation and delays and filters storm water runoff, reducing sewer overflows.

Environmentally friendly materials were used in construction of the green roof. Roof modules were constructed with 100 percent recycled polypropylene. Module plants were obtained from local nurseries, and wood for benches used on site came from a managed forest.

"As a business leader, we are committed to operating in a sustainable and environment-friendly manner," says Alex Miller, president of ESRI Canada. "Our new green roof, along with our other eco-efficiency initiatives, demonstrates our commitment to preserving and enhancing the environment to benefit society and our stakeholders."

The planning phase for the project began in 2007 and was implemented in conjunction with Crown Property Management. Scott Torrance Landscape Architect Inc. provided design services for the project. ESRI Canada qualified for a grant to cover partial costs of building the green roof under the 2009 Eco-Roof Incentive Program for Green Roofs in Toronto.

More Information

For more information, contact Joy Chan, ESRI Canada Limited (e-mail: jchan@esricanada.com, Web: www.esricanada.com).

ESRI Canada Limited's new green roof.

ESRI Latin America and European User Conferences Bridge Countries and Continents

ESRI Asia Pacific User Conference Focuses on Geographic Awareness

ESRI Latin America User Conference

The ESRI Latin America User Conference (LAUC) was held October 7–9, 2009, in Bogota, Colombia. There were more than 800 attendees from 17 countries. More than 30 exhibitors from Latin America, Lithuania, Spain, the United Kingdom, and the United States were also in attendance. Six Special Achievement in GIS Awards were given out to recognize organizations innovating and making a difference with GIS technology in Latin America. The LAUC theme was "GIS: Geography in Action," gearing many of the event's sessions and activities toward putting geospatial technology to work, leveraging it to create profit and opportunities, solve problems, and make better decisions.

"Congratulations for such a spectacular event," said Luis Fernando Cadena, an attendee from Interconexión Eléctrica S.A. (ISA). Patricia Jimenez, from Pritsma Ltda., remarked, "I want to congratulate you on a successful conference—to all the ones involved, the visible and the ones behind the scenes. The result was excellent. The papers, the ESRI staff, the special charm: everything was first-rate." Natalia Castro, from Gobernación de Antioquia, said, "It was a very interesting event—an excellent opportunity to learn."

Merrill Lyew, ESRI's international regional manager for Latin America, said, "The conference was a one-of-a-kind experience. I was amazed at all the knowledge sharing, the ease with which collaboration took place and ideas took hold. And our office was so honored to host this event in hopes that participants would come away with everything they needed; it was meant to be a launching pad for success with GIS."

Learn more about the conference at www.procalculoprosis.com/lauc09.

ESRI European User Conference

The ESRI European User Conference (EUC) was held October 14–16, 2009, in Vilnius, Lithuania, the European Capital of Culture 2009, an honor that showcases a city's culture and development. Three weeks before the conference, 300 people were registered; however, when the event started, there were more than 800 attendees, with approximately 50 percent from outside Lithuania. The 2009 theme was "Geographic Awareness," setting the tone for an agenda full of preconference seminars, more than 100 paper sessions, 80 technical workshops, and other activities that addressed how to apply geography and technology for tangible results in any market. The paper sessions' utilities, transportation, and defense and national security tracks were especially popular. Many of the technical workshops had so many visitors, the audience overflowed into the host hotel's corridors.

Jack Dangermond, president of ESRI, shared his vision for GIS during the Plenary Session. The keynote presentations included talks given by Zymantas Morkvenas from Lithuania's Baltic Environment Forum; Jennifer Newlands from France's Spot Image; and Linnar Viik, Estonia's e-government expert. There was also a special presentation given by secondary schoolchildren about their first experience with GIS.

"We are very excited about the enthusiasm of the participants, the active participation, and growing interest in GIS," said Linas Gipiskis, managing director of HNIT-BALTIC, UAB, ESRI's distributor in Lithuania. "We had attendees from 37 countries, including all the European countries, Russia, Chile, Oman, and the United Arab Emirates."

During the EUC, Dangermond signed a memorandum of understanding (MOU) with the Ministry of Education in Lithuania to stimulate getting ArcGIS software site licenses set up in all the country's universities and 14 colleges. Another event highlight was the Gala Dinner at the old country estate Belmontas, where different kinds of music, from opera to pop; interesting handicrafts; and good food were a hit.

Find out more about the gathering at www.esri.com/euc.

ESRI Asia Pacific OZRI User Conference

The 2010 ESRI Asia Pacific User Conference (APUC), combined with ESRI Australia Pty. Ltd.'s 2010 user conference (OZRI), will take place March 3–5 on Queensland's Gold Coast, Australia, at the Conrad Jupiters Hotel. This new combination provides a larger forum for users to network and strengthen their GIS knowledge and skills.

With presentations based on the theme "GIS: Extending the Reach," the conference will explore how GIS has evolved from being seen as a tool to simply pair location and information to being acknowledged as a serious business system that delivers real benefits. The event will address four aspects of extending the reach of GIS and delve into how today's location intelligence solutions are making it easier for users to extend the reach of GIS globally, technically, in business, and in their own GIS projects.

"The conference offers a great opportunity for attendees across the Asia-Pacific region to extend their networks and learn how others are using location intelligence in innovative ways," says Brett Bundock, CEO of ESRI Australia.

There will be a welcome cocktail party on opening night, and Dangermond will give the Keynote Address during the Plenary Session. Technical experts and industry specialists from ESRI and ESRI Australia will also be presenting during the plenary and on hand throughout the conference to help answer questions. Numerous exhibitors will be available to discuss some of the most cutting-edge technology solutions related to GIS. Plus, user presentations will unearth more about how GIS and location intelligence have been extended in different industries and organizations across the region.

Registration is available at www.esriaustralia.com.au/ozri2010.

More Information

For a complete list of ESRI events worldwide, visit www.esri.com/events.

Thousands of Sites Worldwide Celebrate GIS Day 2009

North Bay GIS User Group, Santa Rosa, California
"Do More with Less" was the theme for the North Bay GIS User Group's event in Santa Rosa, California. "In the current economic times, we all need to do more with less," states Kevin Lacefield, GIS programmer analyst with the County of Sonoma. "The goal for our GIS Day event was to show area businesses and decision makers how GIS can help them do that." The event was open to the public and featured presentations, demonstrations, a map gallery, and a student map contest. Also included were facilitated panel discussions on the economic benefits of GIS for business leaders, how to get educated in the field of GIS, and government uses of GIS.

McKinley Elementary School, Santa Barbara, California
"It was one of the best experiences I've ever had." That sentiment, expressed by Patricia Carbajales, geographer, GIS Projects with the University of California, Santa Barbara, probably sums up how many GIS Day event hosts feel now that their celebrations are complete and they've had time to reflect on the outcome of their events.

GIS Day 2009 was celebrated at more than 1,000 sites around the world. It is rewarding and inspiring to read how event hosts celebrated the day and took advantage of the opportunity to share their knowledge and passion for GIS with others. Following are a few examples.

For her GIS Day event, Carbajales held an interactive seminar with fourth and fifth graders at McKinley Elementary School in Santa Barbara to introduce them to GIS. Using her laptop and with the help of a volunteer, they played the Treasure Hunt game available on the GIS Day Web site as a group exercise. Carbajales says, "The students' response and enthusiasm were what made it so special to me. The event was such a success that I am planning to repeat it this coming fall."

Above: Focusing on mapping at the University of Missouri. Left: Asmara, Eritrea, GIS Day event.

Asmara, Eritrea
The Education Sector Development Program–Project Management Unit in Asmara, Eritrea, held a conference for its GIS Day event. The purpose was to show how GIS is important for the nation as a whole and for education as a planning tool. Eritrea is a country in the Horn of Africa with an estimated population of 4 million. Conference organizers wanted to demonstrate how GIS helps officials in the Ministry of Education determine the country's enrollment ratio through analysis of resource allocation, distribution of materials, and deployment of teachers. They also wanted to show how GIS plays an important role in site selection and rehabilitation of schools.

New Mexico State University
The New Mexico State University (NMSU) Geography Department hosted what is the first known GIS Day event held primarily in a virtual world. Using Linden Lab's Second Life, an immersive 3D virtual environment, students met in NMSU's Island learning community to share projects and posters demonstrating their GIS class activities with attendees in both the real and virtual worlds. Students were available throughout the day to describe their projects and help educate those not familiar with GIS about the technology. The event was mainly designed for university educators interested in the use of Second Life as a venue for teaching GIS but was open to everyone.

University of Missouri's Department of Geography
Dr. Shannon White of the University of Missouri's Department of Geography hosted a three-day camp for sixth through ninth graders focused on mapping and geospatial technology tools that assist in geographic analysis. Students participated in many hands-on and outdoor activities related to geography and mapping, including making their own compasses, creating personalized life maps (where they had been and where they wanted to go), exploring aerial and satellite images, and importing their own GPS data into GIS software to create their own maps. In addition, campers used GPS units to locate a geocache on campus and collect waypoints while orienteering at Rockbridge Memorial State Park. Kathryn DiFoxfire, a member of the Rockbridge interpretive staff, led the campers and geography chaperones through orienteering exercises and cave mapping and exploration in Connors Cave. Other partners in the camp included USGS, which provided take-home resources and maps, and ESRI, which provided free GIS software for each of the campers.

The Overseas School of Colombo, Battaramulla, Sri Lanka
The Overseas School of Colombo in Battaramulla, Sri Lanka, is a small school of about 400 K–12 students. It is in a unique position in that many of the students' parents work in nongovernmental organizations and relief/development organizations, including UNICEF, the United Nations Development Programme, World Food Programme, and World Health Organization, and use GIS to do their work better. To celebrate GIS Day, Ian Lockwood, the environmental systems and geography teacher, asked a few of these "in-house experts" to give his students in grades 10, 11, and 12 presentations on the use of GIS in development and humanitarian work. A representative from the International Water Management Institute gave the keynote address, and the celebration included a map gallery for students, teachers, and parents to observe and appreciate.

Arkansas' Pulaski Area Geographic Information System
For its GIS Day celebration, the Pulaski Area Geographic Information System chose the theme "Developing Central Arkansas Using GIS." The event showcased how GIS technology has advanced economic development in the region and state. Key participants included Arkansas state senator Shane Broadway and Entergy Arkansas. Broadway gave a presentation entitled "The Importance of GIS for Economic Development" in which he discussed the impact GIS had on a recent project in Saline County. The Entergy Arkansas Department of Economic Development shared how GIS technology aided in creating the Arkansas Site Selection Center (**www.arkansassiteselection.com**), which tracks demographic information for a Web mapping application showing available buildings and sites to locate new business. The event also included a demonstration by the Arkansas Geocachers Association; poster and map displays; and demonstrations, including one given by area high school students on "How Students Utilize Online GIS Resources."

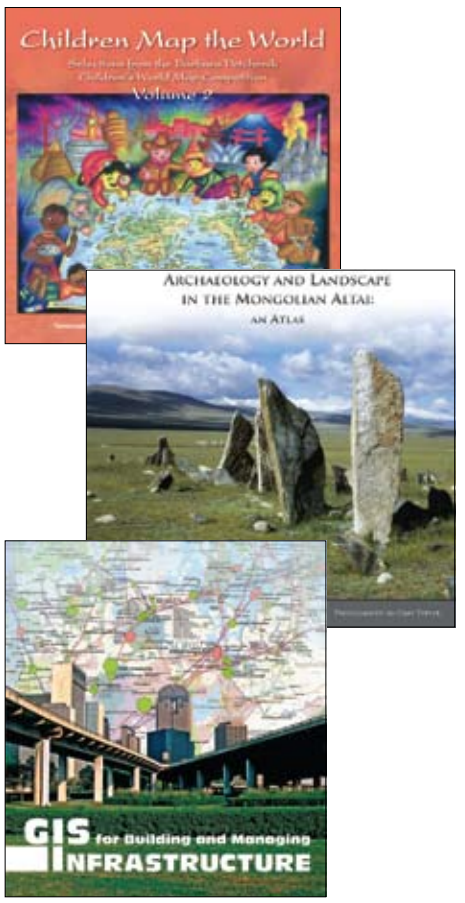
Mark Your Calendar
GIS Day 2010 will be held Wednesday, November 17. It's never too early to start planning. For inspiration, visit **www.gisday.com/success** to read how other organizations and individuals celebrated in 2009.

Join the GIS Day Discussion
Stay connected to GIS Day throughout the year:

- Follow GIS_Day on Twitter.
- Become a fan of the GIS Day page on Facebook.
- Post a question or idea on the GIS Day Discussion Forum on the ESRI Support Center (**support.esri.com**).

New ESRI Press Books Offer Graphic Representations of Our World

- *Children Map the World: Selections from the Barbara Petchenik Children's World Map Competition,* Volume 2—This vibrant collection displays maps from young artists from around the world, ranging in age from 4 to 15. The maps represent the 2005–2007 theme, "Many Nations—One World," of the biennial Barbara Petchenik Children's World Map Competition, which is sponsored by the International Cartographic Association. ISBN: 9781589482463, 136 pp., $29.95
- *Archaeology and Landscape in the Mongolian Altai: An Atlas*—This book examines the distribution of ancient surface archaeological discoveries within the mountainous region of northwestern Mongolia. Using location and photographic data in the field, the authors created GIS maps to study the cultural landscape and cultural preservation of the Altai, one of two mountain ranges found in Mongolia. Rich in photographs and maps, this atlas conveys the heritage of this rugged environment. ISBN: 9781589482326, 225 pp., $79.95
- *GIS for Building and Managing Infrastructure*—This map collection highlights 57 different organizations that have incorporated GIS technology into the development, management, and administration of their infrastructure projects and will likely serve as a model for others involved in comparable infrastructure initiatives. A community wildfire protection plan, an identification of structurally deficient city bridges, a study of the potential impact of a proposed development within an existing environment, and an exploration of urban taxi demand for dispatch efficiency are just a few of the infrastructure projects illustrated in the book. ISBN: 9781589482524, 72 pp., $24.95



More Information
For more information about these and other books from ESRI Press, visit **www.esri.com/esripress**.

NATIONAL GEOGRAPHIC™

"Geo Learning"

A column by Daniel C. Edelson,
Vice President for Education, National Geographic Society

The Importance of Innovation in Teaching

Giving people an image of what learning could be like is a really important part of improving education. Students, teachers, administrators, parents, policy makers, and community members have remarkably similar views of what education looks like, and those views have not changed much since we were in school.

Despite the fact that the dominant image is in conflict with much of what we know about how children and adolescents learn best, it is deeply ingrained in our culture. It is so ingrained that approaches to education that differ from this model are typically met with resistance by participants and stakeholders.

If you want to make students and teachers uncomfortable, ask them to work in a configuration that goes against convention. Ask most American high school students to sit in a circle or to share their work with others in small groups, and they will squirm with discomfort. Ask most American principals to evaluate the quality of teaching and learning in a classroom in which students are moving around the classroom, talking and arguing, and making messes, and they will conclude that the teacher is unable to control the students and that learning is being undermined by the disorder. And yet, these are precisely the kinds of conditions that have been shown to maximize learning.

Along with traditional views about the conditions that lead to learning, most of us carry around traditional views about what constitutes learning. Most of us were educated in a system that focused very heavily on learning facts, and we still tend to associate the state of being well-educated with knowing a lot of facts. Even as we say that 21st-century citizens and workers need to be able to think critically, solve complex problems, and work in teams, we assess the progress of students in terms of what they know.

If we are serious about educating a generation of geo-literate citizens, it is important that we break down our own out-of-date views about learning and replace them with new images of how we should educate young people and what kind of knowledge and skills we should be aiming for. Here's an example.

Consider the following two descriptions of how teachers might teach the first day of a unit on climate for eighth graders. (These are fictionalized composites based on real teachers and students.)

In one classroom, Ms. Brown projects several maps displaying global distribution of temperatures at different times of year and asks her students to identify and discuss interesting patterns.

In her classroom, Ms. Scarlet gives each of her students six crayons and a map of the world displaying continent outlines. She asks them to draw their best guess of what the distribution of temperatures is like all around the world in the month of July.

The day before, when Ms. Scarlet told Ms. Brown about this activity, Ms. Brown warned her she was making a big mistake. Ms. Brown told Ms. Scarlet that her eighth graders will get frustrated because they won't know enough to color the map in. Worse, she argued, the students are likely to draw things that are incorrect, and it's dangerous to have students do things like that if you won't be able to correct them.

At the beginning of her lesson, Ms. Scarlet grew concerned that Ms. Brown had been right. Even though they were excited about getting crayons, her students were slow to start drawing, and Ms. Scarlet saw them looking nervously at each other's papers. After a few minutes, though, they became very engaged in the temperature-drawing activity. In fact, she only wanted them to spend 5 minutes drawing their temperature maps so she could begin discussing them, but her students insisted on taking 10. When she asked them what they drew and why, two-thirds of the students' hands shot up. Over the course of the discussion, several students shouted questions out of turn about what the "real" temperatures were and why temperatures are different from place to place. At the end of the discussion, in which students voiced many thoughts—some right and some wrong—about the factors that influence temperature, they practically begged her to show them a map of global temperature distributions.

In Ms. Brown's class, on the other hand, the lesson was very different. After Ms. Brown put her global temperature maps on the projector, she had to ask three different prompting questions about what they saw in the map and wait a full 30 seconds—an eternity in front of a classroom—until one student reluctantly raised her hand and said, "It looks like it's warmer closer to the equator." After a few more minutes of discussion, in which a handful of students each identified a pattern, Ms. Brown instructed them to take out their books and start reading about the causes of temperature variation.

Ms. Scarlet's approach made Ms. Brown uncomfortable. She didn't like the unfamiliar practice of asking students to do a task before they'd been taught to do it. It even made the students uncomfortable at first. They aren't used to speculating, and Ms. Scarlet had to reassure them that they wouldn't be graded on their maps or even asked to hand them in.

However, in the end, Ms. Scarlet's activity was much more engaging to students, and it achieved its goal more effectively than Ms. Brown's. Both activities were intended to get students to notice patterns in global temperature and develop interest in the sources of those patterns. Ms. Brown's assumed that students would be naturally motivated to notice differences and be curious about them. Ms. Scarlet's recognized that they wouldn't be, and it engaged them in an activity in which they had to draw on what they knew in a way that made them curious about what they didn't know. Ms. Scarlet's lesson is also based on research that says that if you ask students to articulate their current understanding of a phenomenon before you teach them something new about it, they learn the new material more effectively because they can connect it to their existing understanding. Ms. Brown was afraid the map-drawing activity might reinforce a student's misconception, but in fact, the reverse is true. By eliciting students' misconceptions, a teacher increases the likelihood that they will replace the old in their memories with the new.

More Information

For more information, contact Daniel C. Edelson (e-mail: dedelson@ngs.org). Visit the GeoMentor program at **geomentor.org** and National Geographic Fund for Geo-Literacy at **www.nationalgeographic.com/foundation/geographic_literacy.html**.

"Crossing Borders"

A column by Doug Richardson,
Executive Director,
Association of American Geographers

GIScience and Climate Change

Geographers and GIScientists have long played key roles in climate change research, and the tools and methods of geography—including GIS—will be crucial to understanding, limiting, and adapting to climate change in the decades ahead.

After years of delay and denial, responsible climate change research and responsive policy agendas are now assuming center stage in President Barack Obama's administration. Nearly all federal agencies now have legacy or newly mandated and funded research programs that actively seek to identify causes and impacts of global climate change and policies for mitigating or adapting to these impacts. Geography and GIScience, with long experience in the integration of the physical and social sciences, offer a well-placed bridge that can bring together the disparate natural and human system elements of climate change research and policy.

The U.S. Congress is now poised to undertake debate and potential definitive legislative action on several major climate change bills during the spring of 2010, precisely during the time frame of the AAG's upcoming Annual Meeting in Washington, D.C. For these reasons and more, "Geography and Climate Change" has been designated as the key overarching theme of the AAG's Annual Meeting to be held April 14–18, 2010. Both the timing and the venue of this particular AAG Annual Meeting afford to geographers and GIS specialists around the world a uniquely significant opportunity to showcase the potential contributions of geography and GIS to climate change research and to engage and influence U.S. and international policy on climate change at a critical juncture in its formulation. This will be a most meaningful moment for the geography and GIS community to interact with federal agency researchers and U.S. national policy makers on perhaps the most consequential issue of our generation, both at the AAG meeting itself and throughout the city, including on Capitol Hill.

The AAG currently has invitations pending to several high-level Obama administration officials to attend and speak at our AAG gathering, expected to number 7,000 attendees. Based on the responses we have received to date, we anticipate that numerous senior climate change officials and scientists will be in attendance and that the dialog at this meeting will provide an important national and international forum for addressing and moving forward key science and policy dimensions of the climate change issue.

Many special sessions on climate change at the meeting will bring together top scientists and climate change policy leaders to explore coordination and synergy of climate change research and mitigation programs across multiple government agencies and enhance collaboration among governmental researchers and policy makers, university researchers, private-sector GIS firms, and educators.

For example, the Opening Keynote Session of the AAG Annual Meeting will focus on America's Climate Choices, a major ongoing National Academy of Sciences (NAS) study in which geographers and GIScience have played a central role. This study will be released just prior to the meeting, and this special opening session will be one of the first public presentations of the study's results. A primary goal of the NAS America's Climate Choices study is to address cross-cutting science and technology challenges involved in understanding our climate and to identify effective steps and promising strategies that can inform and guide the nation's responses to climate change.

Geography and GIScience are exceptionally well represented in the NAS study, with three of the study's four investigative panels led or co-led by geographers and many other geographers involved in key components of the research. Presenters at this AAG presidential session on America's Climate Choices will include Diana Liverman of the study's Informing Decisions panel, Marilyn Brown of the Limiting Emissions panel, Tom Wilbanks of the Adapting to Impacts panel, and Billie Lee Turner of the Advancing Science panel. Other geographers and GIScientists involved in the NAS study include Ruth DeFries, Bob Kates, Susi Moser, Jim Buizer, and Linda Mearns.

Dozens of other sessions addressing geographic dimensions of climate change will be held at the AAG's Washington, D.C., meeting. These include, among many others, discussions of three new AAG programs focused on climate change education and teaching; perspectives on the use of GIS in climate change regulatory and enforcement strategies, including cap and trade scenarios; a 10-year retrospective analysis of the AAG's *Global Changes, Local Places* research program and publication, with implications for current policy and research in the climate change field; and several sessions sponsored by U.S. federal agencies on fostering interagency synergies and coordination of climate change programs. Numerous other sessions will cover the full gamut of current climate change research, ranging from carbon sequestration and climate change modeling to vulnerability analyses and social equities of climate change control and adaptation policies.

I encourage geographers and GIS specialists from around the globe to bring to the fore their research, GIS applications, and perspectives on climate change during the coming pivotal months of this debate. The AAG's Annual Meeting in Washington, D.C., may well represent the most important time and place for geography to engage and influence the far-reaching science and public policy (and inherently geographic) decisions now coming before us on the issue of climate change.

Doug Richardson
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Egypt and Indonesia— ESRI T-Shirts Get Around!

Claire M. Hay, assistant professor of Geography, Earth & Atmospheric Science Department, Metropolitan State College of Denver, Colorado, packed her ESRI T-shirt and went to Egypt, where she visited the Sphinx and the Pyramids and sailed on the Nile south of Luxor for five days.

Steve Brown, GIS analyst, City of Overland Park, Kansas, and his family took a monthlong journey to Indonesia. One of their many stops was the active volcano Mt. Bromo in East Java. He says, "My wife and I met in Indonesia 33 years ago, and this was a return to our roots." Then he added, "I've been waiting for years to return and wear an ESRI T-shirt!"

Wear an ESRI T-shirt in a unique location and send a photograph to *ArcNews*. Photos will be considered for use in *ArcNews,* the expanded T-shirt section at *ArcNews* Online, or both. While digital photos sent via e-mail (tmiller@esri.com) are preferred, prints or slides can be sent to Thomas K. Miller, *ArcNews* Editor, *ArcNews* T-Shirt Feature, ESRI, 380 New York Street, Redlands, California 92373-8100 USA. See *ArcNews* Online at **www.esri.com/arcnews**.

Steve Brown

Claire M. Hay

URISA Headquarters and Web Site Change

URISA, the association for GIS professionals, not only launched a new Web site in recent months but also moved its headquarters office. The organization is preparing for another busy year.

URISA's Web site, **www.urisa.org**, now includes forums, blogs, RSS feeds, and significant resources for members. In addition, both conference registration and dues payment have become much more efficient through an e-commerce integration. Check it out!

Taking advantage of a surplus of commercial real estate in the Chicago, Illinois, area, the URISA staff recently moved into new office space in Des Plaines, Illinois. URISA had been in its previous space since 1997. The new office space is in a more modern building with lots of light and amenities, situated next to a Metra metropolitan rail stop. There is also a classroom in the building, where URISA will offer its Certified Workshops periodically throughout the year.

URISA has a full slate of educational programs on its agenda for 2010:

- GIS/CAMA Technologies Conference—March 8–11, 2010, Little Rock, Arkansas USA
- URISA/NENA Addressing Conference—August 16–18, 2010, Charlotte, North Carolina USA
- URISA 2010 Annual Conference—September 28–October 1, 2010, Orlando, Florida USA
- URISA's Fifth Caribbean GIS Conference—November 29–December 3, 2010, Trinidad

Check out all URISA's programs for GIS professionals at **www.urisa.org**.

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Data Collection

Science Applications International Corporation (SAIC)
www.georover.com
GeoRover Product Line
The GeoRover line of solutions provides tools for rapid data editing and import, GPS support, and field data collection. These tools are designed as extensions to ArcGIS Desktop and can be used directly within ArcMap. This integration provides a flexible, easy-to-use solution for a variety of applications across many industries and domains.

Electric & Gas Utilities/ Telecommunications

3-GIS
www.3-GIS.com
Network Express
Network Express is a Web-based GIS solution that allows users to seamlessly edit, query, plot, and report data in an easy-to-use interface. Built on ArcGIS Server Advanced Enterprise, Network Express maximizes a utility or telecommunications company's GIS investment by providing an easy-to-operate asset management design tool that reduces IT burden and provides improved access to data. Network Express allows the collection, management, and dissemination of geospatial data across the enterprise.

Public Safety

Bergmann Associates
www.bergmannpc.com
First Responder Mobile
First Responder Mobile (FRM) is a mobile navigation, operations, and intelligence solution for public safety professionals. Based on ArcLogistics Navigator and ArcGIS Mobile technology, First Responder Mobile improves situational awareness for first responders by fusing foundational GIS data with disparate data sources, such as real-time 911 incident data, voice-directed navigation, building layouts, tactical plans, and safe schools information. Combining the functions and ease of use found in portable navigation devices (PNDs) with the power of mobile GIS, FRM provides public safety personnel with the increased ability to analyze and respond to events as they unfold by using a common, map-based view of operations.

Transportation/Land Management

Smart Data Strategies, Inc.
www.sds-inc.com
DREAMaps 10.0
DREAMaps is a Web-based suite of products for managing complex workflows associated with land management, right-of-way management, and permitting. DREAMaps extends the ArcGIS Server platform by providing advanced reporting and analytic capabilities that increase the accessibility and usability of an organization's data. DREAMaps also offers an executive dashboard that provides administrators with convenient snapshots to track work productivity and performance, as well as the status of outstanding items.

Water/Wastewater

MWH Soft, Inc.
www.mwhsoft.com
CapPlan Water and CapPlan Sewer
CapPlan Water and CapPlan Sewer run as ArcGIS extensions with the MWH Soft InfoWater and InfoSWMM packages. CapPlan helps utilities decide which pipes in their infrastructure are the riskiest and should be prioritized for rehabilitation or replacement. Risk is calculated by utilizing hydraulic modeling data, pipe condition information, and GIS background layers to determine the likelihood and consequence of failure for each pipe in the system. CapPlan Water and CapPlan Sewer also include tools to manage rehabilitation methods, budgeting, and phasing.

Spatial Wave, Inc.
www.spatialwave.com
Spatial Wave Water Suite
Spatial Wave Water Suite is an enterprise solution that helps water agencies maximize their GIS investment in a multifaceted workforce environment. From the office, the suite operates on ESRI and Microsoft technology to unify dispersed business and operations information into a GIS-centric Web portal. In the field, the suite allows daily operation, such as call-before-you-dig, valve turning, hydrant flushing, water quality sampling, unidirectional flushing, inspections, and work requests, to be GIS aware.

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As part of a development team at ESRI, you will help build leading-edge software and support our customers in areas including 2D and 3D visualization and spatial analysis, robust server-based GIS, enterprise solutions, and database and applications development. Your contributions will have a real impact on the next generation of our innovative geospatial analysis, modeling, and visualization technology. We are looking for software engineers and GIS professionals who have the skills and the mind-set to thrive in a challenging, cutting-edge environment.

GIS Services

A career on our professional services and consulting team gives you the opportunity to collaborate with our customers to support innovative database and applications development, service-oriented architecture, and enterprise software solutions. The variety of project work enables you to use your GIS expertise and software development, database engineering, and project management skills in a number of growing markets, such as natural resources, commercial, government, utilities, homeland security, and defense. Join this growing team and help our customers convert their GIS technology needs and expectations into practical, state-of-the-art solutions.

Educational Services and Technical Support

Share your knowledge and passion for GIS with our customers around the world. As a member of our Educational Services Division, you'll have the opportunity to help our customers continue to learn about GIS and ESRI technology, whether by teaching a class in our regional offices, developing content for a Web-based course, or providing world-class technical support. We are seeking dynamic individuals who are subject matter experts with an education in GIS-related fields and experience with ESRI software. Join us in our mission of helping our customers achieve success with ESRI products.

Sales

As a member of our sales team, you will use your technical experience, consulting skills, and results-driven focus to sell solutions—not just features and functions—to help our customers find a smarter way to do business. Leverage your sales experience and industry knowledge to support our customers' ongoing needs for spatial technology in high-growth areas, including commercial business, utilities, petroleum, state and local government, defense, and the federal government. Join our unique sales organization, where you can help our customers make a real impact on society.

Marketing

Print Publications Writer/Editor—Utilize your strong writing skills and passion for GIS to help with the production of our quarterly publications, *ArcNews* and *ArcUser,* which reach almost one million readers. In this role, you will write and edit articles, tutorials, case studies, announcements, and other text, as well as manage relationships with contributors and other ESRI teams.

Petroleum Industry Marketing Specialist—Put your years of experience to use in this critical position working with ESRI's petroleum and pipeline customers around the world. In this role, you will focus on serving our established user community and helping broaden the applicability of ESRI's software solutions within the wider petroleum sector.

Logistics Industry Solutions Manager—A creative, dynamic professional is needed to work in the challenging logistics and supply chain industry, helping market ESRI's software solutions to clients worldwide. Develop, manage, and execute a comprehensive marketing, business development, and business partner plan to further grow the use of GIS in the logistics market.

www.esri.com/careers

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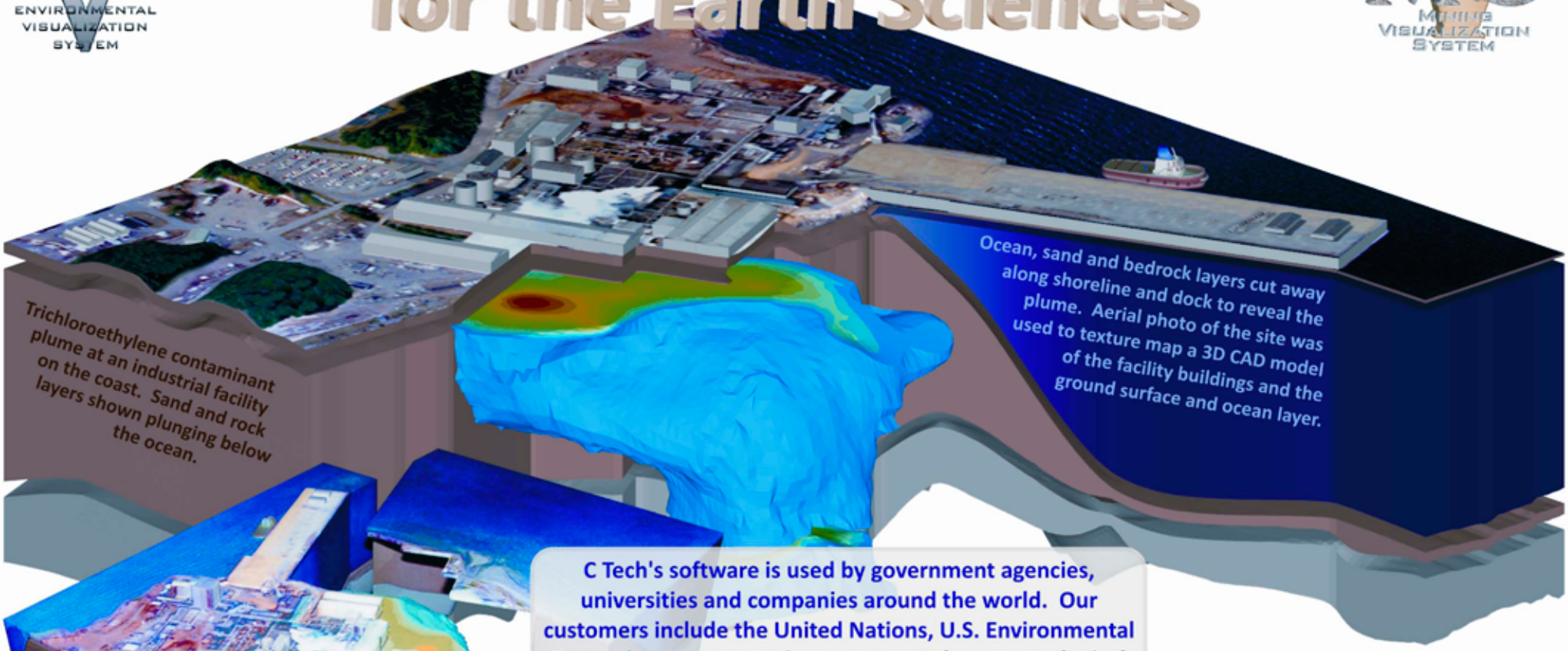
3D Analysis and Visualization for the Earth Sciences

ENVIRONMENTAL VISUALIZATION SYSTEM

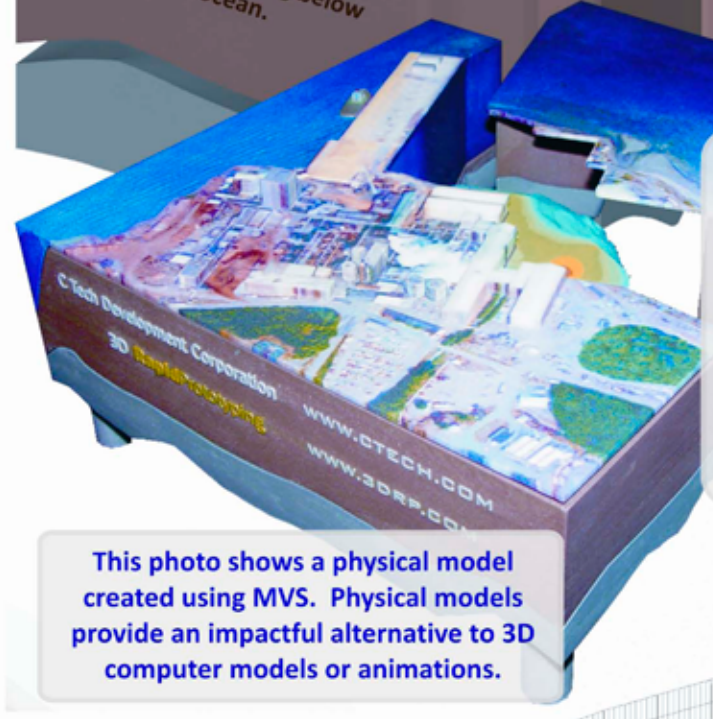
MINING VISUALIZATION SYSTEM



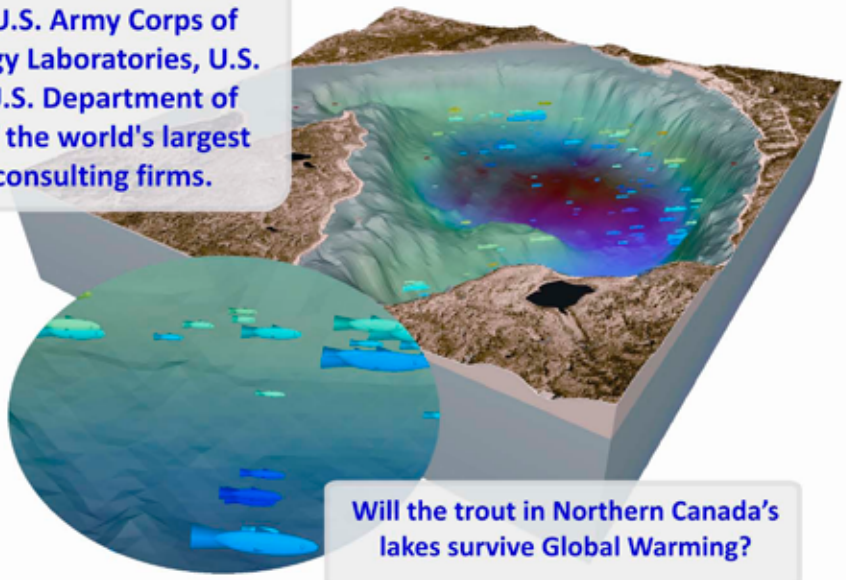
Trichloroethylene contaminant plume at an industrial facility on the coast. Sand and rock layers shown plunging below the ocean.

Ocean, sand and bedrock layers cut away along shoreline and dock to reveal the plume. Aerial photo of the site was used to texture map a 3D CAD model of the facility buildings and the ground surface and ocean layer.

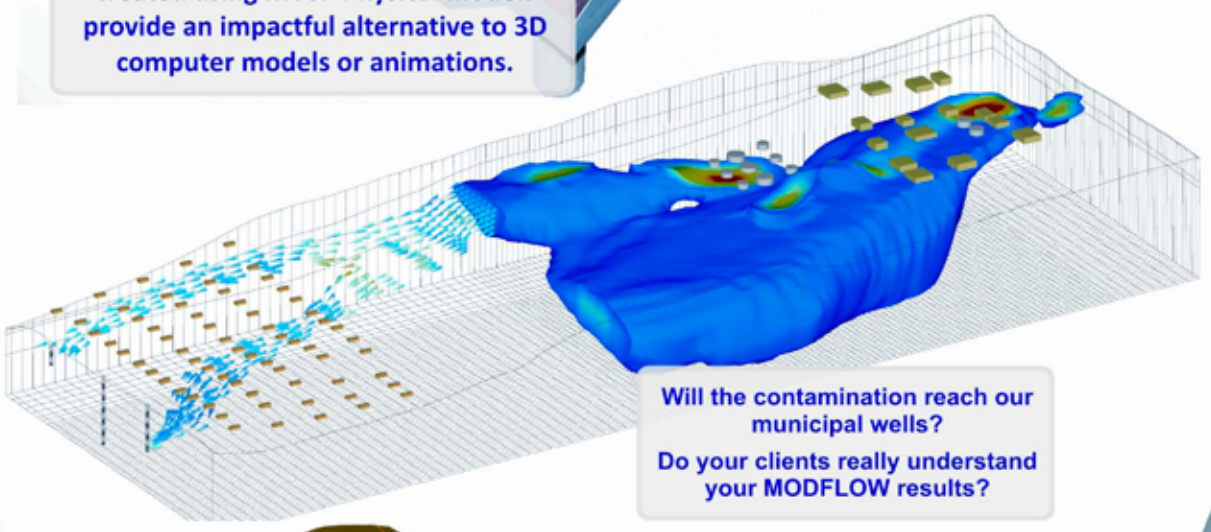
C Tech's software is used by government agencies, universities and companies around the world. Our customers include the United Nations, U.S. Environmental Protection Agency, Environment Canada, U.S. Geological Survey, British Geological Survey, U.S. Army Corps of Engineers, U.S. Department of Energy Laboratories, U.S. Nuclear Regulatory Commission, U.S. Department of Transportation, and the majority of the world's largest engineering and environmental consulting firms.



This photo shows a physical model created using MVS. Physical models provide an impactful alternative to 3D computer models or animations.

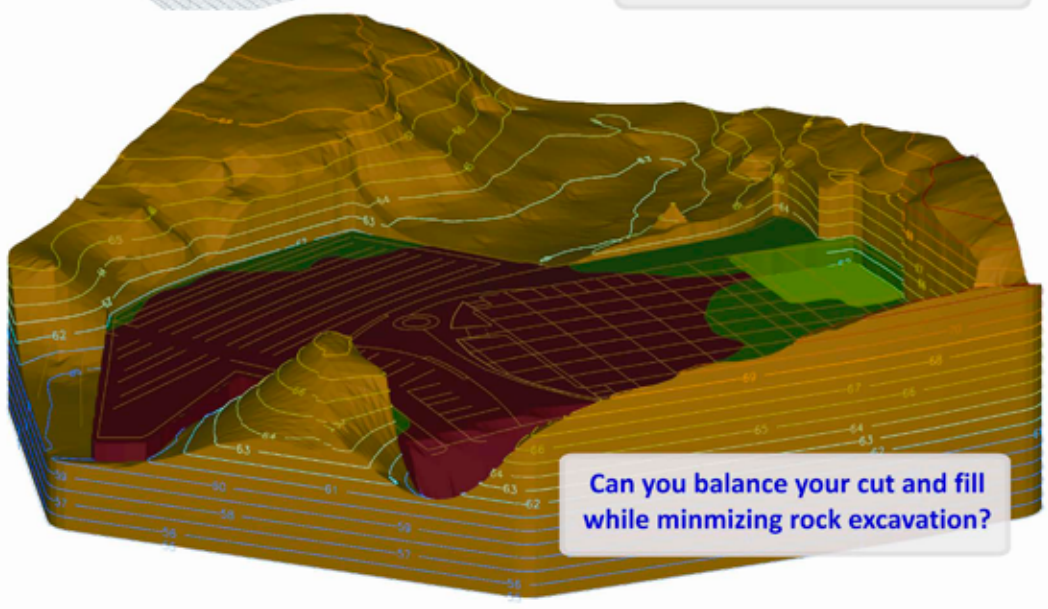


Will the trout in Northern Canada's lakes survive Global Warming?

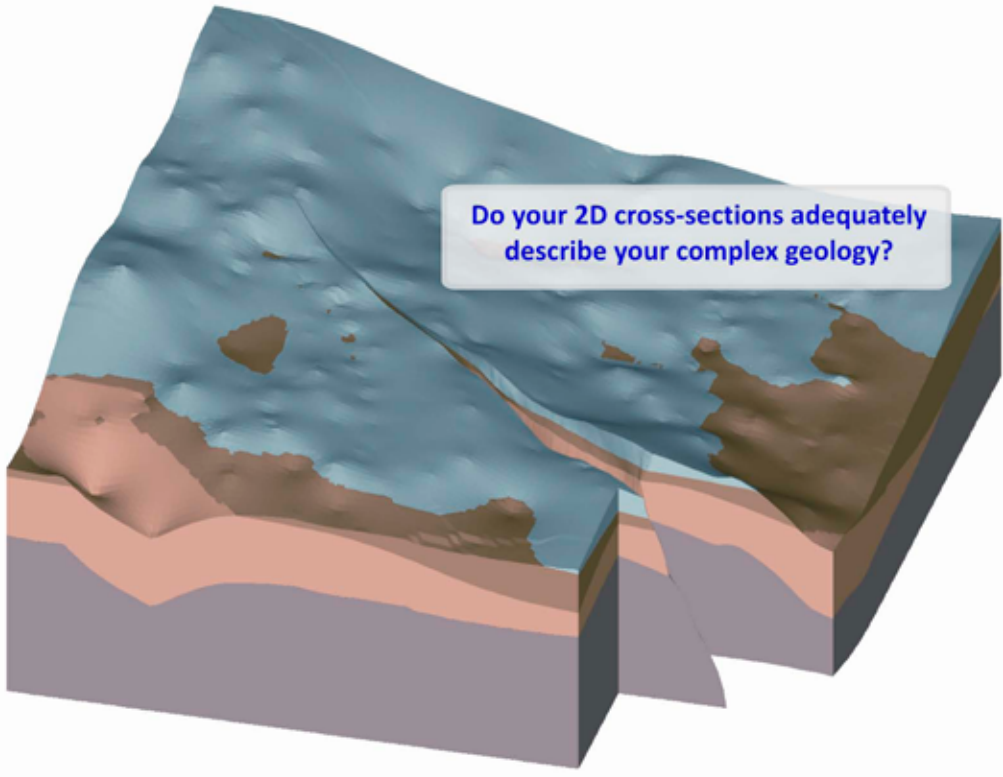


Will the contamination reach our municipal wells?

Do your clients really understand your MODFLOW results?



Can you balance your cut and fill while minmizing rock excavation?



Do your 2D cross-sections adequately describe your complex geology?

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