April 2013

GIS in South America

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What Is GIS?

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

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

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

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

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

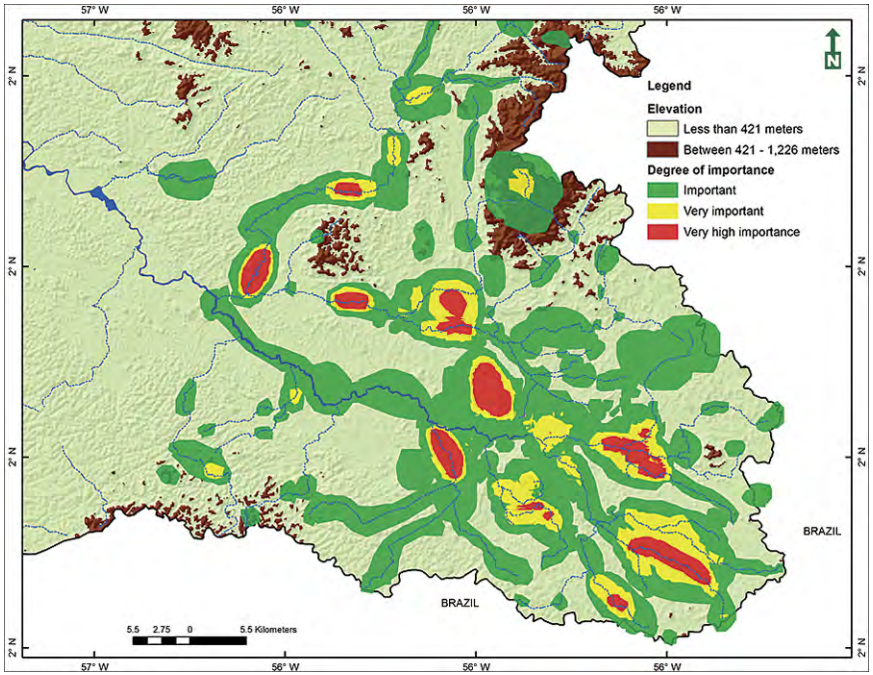
Participatory GIS

Indigenous Communities in Suriname Identify Key Local Sites

Sara O. I. Ramirez-Gomez and Christian Martínez

The nation of Suriname is tucked up against the Atlantic Ocean in northeastern South America. Southern Suriname is covered with continuous tracts of unspoiled tropical forest, and it is the home of approximately 2,000 Wayana and Trio indigenous peoples. The area is currently remote, and economic development is practically nonexistent, which has helped it remain intact. However, several economic development projects for the area are becoming priorities for the national government, including mining, hydroelectric dams, and road construction. While these investments may benefit Suriname, they also pose a threat to Suriname's ecosystems and local communities' livelihoods, fundamentally in the lack of socioecological information. In the absence of reliable information, the decision-making process will fail to include local people's needs in terms of land and natural resources, bringing further inequity and poverty to vulnerable people in the country.

Conservation International Suriname (CI Suriname) is working with five indigenous communities in southern Suriname to produce maps depicting perceived importance for landscape services. Through this work, the organization is supporting the development of a visual tool for tribal communities to facilitate their interaction with government planners and external institutions in all issues related to their territory.



Map of the Sipaliwini village's perceived importance of the landscape for subsistence, based on the count of overlapping locations.

To foster progress with informed decision making, CI Suriname is undertaking participatory mapping processes that produce spatial information to support a community bottom-up approach in the land-use decision-making process. To do this, the project team looked for a way to combine community mapping with GIS technology to put people's spatial knowledge into digital maps that could be incorporated into conservation planning. As a longtime user of Esri technology, CI Suriname chose ArcGIS to build a tool to effectively count the times that thousands of polygons were overlaid to produce maps showing the frequency of landscape services polygons as surrogates of importance; the more overlays, the more use of the area and thus the more important the landscape for the indigenous people.

To produce these maps, the development of an operational tool was needed to count the number of times that the landscape services polygons were overlaid. This tool combined several ArcGIS tools to effectively map intensity of use. The input data was obtained through social mapping workshops with community participants in five Amerindian villages of South Suriname. During the data collection process, people were prompted to individually indicate, by drawing polygons on a georeferenced landscape map, the areas that they use for four distinct landscape services. The services were distinguished by using different color markers: subsistence (red), income-generation-related services (blue), culture (orange), and life-sustaining services (green). The number of maps produced during the workshops coincided with the number of participants. The polygons in each of these maps were then digitized in ArcGIS, queried by the landscape service they represent, and prepared for the data analysis process. At this stage, thousands of polygons were processed.

A village woman drawing polygons on an elevation map.

Using the ModelBuilder environment in ArcGIS, a tool was developed to count overlapping polygons inside a shapefile, and

a new shapefile was created with polygons whose attributes are the number of overlaps identified in that specific spatial unit. The developed tool has a simple user interface: it first asks for an input shapefile, which has all the polygons mapped in the area, and then it asks the name and location of the output shapefile. CI Suriname uses this tool to identify concentrations of important places for provision of landscape services according to the perceptions of local people.

ModelBuilder flexibility lets CI Suriname integrate available tools to create a new user-designed tool able to process a large amount of information and with a user-friendly interface. Identification of the areas important to local people is useful input to develop sustainable action plans and support decision making. Indigenous communities see the importance of the maps to facilitate dialog with outsiders. Some of the villagers highlighted the importance of the maps for tourism, while others highlighted their importance for future generations.

Kapitein Euka, the chief of Sipaliwini village, is a firm advocate of ensuring that the natural environment remains intact so that his village can continue to exist. At a meeting with CI Suriname, with whom villagers have created maps showing the areas and ecosystems they depend on, he said, "It is important for us to be able to show the government what parts of land are necessary for our way of life and are important to us." He added that he thinks the maps are vitally important to this cause, especially if future infrastructural development takes place. "It's good that everyone knows about these maps and is aware of how important this land is to our village."

About the Authors

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Amazonian States Map Threatened Borderlands

David S. Salisbury, A. Willian Flores de Melo,
Jorge Vela Alvarado, and Bertha Balbín Ordaya

The 800 kilometers of boundary separating the Peruvian region of Ucayali from the Brazilian state of Acre crosses some of the wildest landscapes left on earth. The lush rain forests of this borderland region still resound with the low grunt of jaguar, while their canopy sways with acrobatic troops of woolly monkeys. Underneath the canopy roam hundred-strong herds of white-lipped peccary and the elusive and elegant ocelot.

This biodiversity inspired parks such as the Sierra del Divisor, Alto Purús, and Chandless reserves, but these forests also hold humans. The "uncontacted" Mashco Piro, Murunahua, and Isconahua indigenous people still move stealthily through the trees, seeking no contact from outsiders or their goods other than the occasional machete. As these people migrate through their reserves and neighboring parks, other traditional peoples, such as the Ashéninka, Yaminahua, and descendants of rubber tappers, live along neighboring rivers and adjacent lands. More recent arrivals include loggers, miners, and drug traffickers seeking to exploit these remote areas for high-value timber, minerals, and trafficking routes.

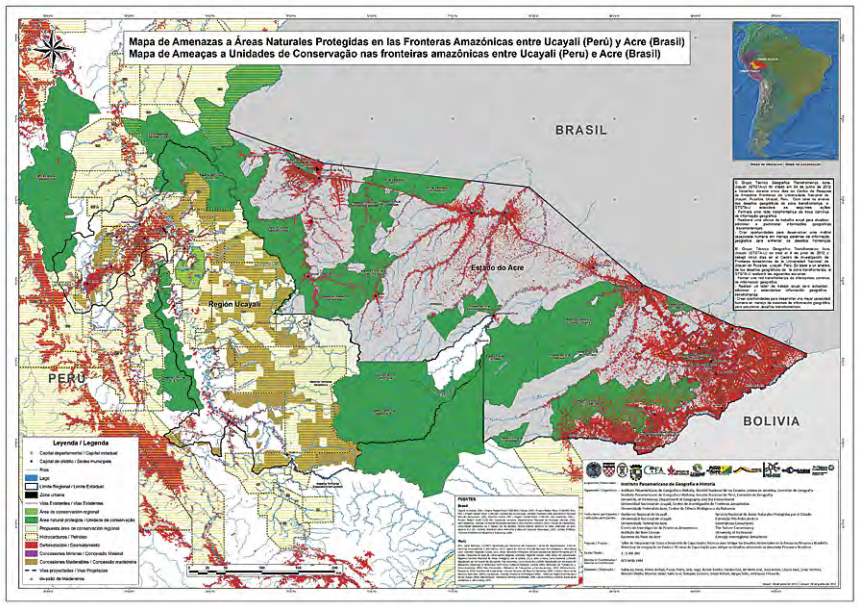
A river in the transboundary region.

Improving Transboundary Planning

Recently, the Regional Initiative to Integrate South America has begun promoting a transboundary road that would bisect the forested borderlands and connect the two largest cities in the region, while the state governments seek to promote a direct ecological railroad alternative. Both transportation

initiatives promise to alter forests and rivers and transform economies and cultures, but these projects also lack the base geographic information necessary to understand their potential transboundary impacts and benefits.

To improve transboundary planning, a grant from the Pan-American Institute of Geography and History was obtained to lead the Workshop to Integrate Data and Improve Technical Capacity to Mitigate Environmental Challenges in the Brazilian and Peruvian Amazon in June 2012.



ArcGIS is used to create a thematic map showing threats to protected areas.

The workshop used GIS as a common language and shared framework to bring together 16 GIS professionals from 13 institutions and two different countries to the National University of Ucayali (UNU) in Pucallpa, Peru. Each of the participants relied on ArcGIS in its home institution and brought work laptops to allow maximum flexibility for organic group work within UNU's Amazon Borderlands Research Center.

Bringing Diverse Areas Together

In the last decade, the Brazilian and Peruvian states have increasingly targeted the borderlands for conservation and development projects but with almost no knowledge of what lies on the other side of their respective boundaries. At the same time, the impacts of illegal logging and drug trafficking have spilled across borders, causing damage to the environment, local livelihoods, and diplomatic relations.

During this weeklong workshop, participants used ArcGIS to create a database and representative map integrating spatial data from both countries. However, before beginning the technical workshop, participants and invited speakers held a conference to educate the public and local policy makers on the importance of geographic information for conservation and sustainable development. Indigenous leaders, university professors, GIS technicians, nongovernmental organization directors, and government officials shared their insights:

- How ecological and cultural diversity permeate international boundaries
- How the environmental challenges on both sides of the boundary are similar
- How local and indigenous populations have been historically marginalized in the borderlands despite their local knowledge and leadership potential to reach transboundary sustainability goals

The conference ended with all participants empowered by the importance of the workshop in providing the information necessary to make informed decisions about natural resources management, development, and conservation along and across political boundaries.

A Common Platform to Standardize Management

Despite their enthusiasm, participants quickly faced numerous challenges, such as different spatial representations of their international boundaries; outdated national datasets; low-quality and missing geographic information; and data with variable scales, datums, and projections. Undaunted, the assembled GIS technicians utilized ArcGIS to standardize the best available data. The participants decided their efforts would focus on creating a capacity-building process and products for improved transboundary management rather than one flawless map. To this end, they divided into three mapmaking groups: threats, protected areas, and ethnogeography.

Each group contained representatives from both Brazil and Peru and used ArcGIS as a common language and arena to make the important decisions necessary for transboundary mapmaking. At the conclusion of the five-day workshop, the interdisciplinary team of participants named itself the Acre-Ucayali Transboundary Geography Working Group and held up three unique transboundary maps as examples of its craft and camaraderie. However, the greatest result of the workshop was the formation of a transboundary network of professionals taking the first step toward an integration based on geographic understanding rather than speculation and uncertainty.

To continue building on the workshop, the participants signed a document declaring their intention to meet annually to continue to build a transboundary network of geographic information interchange and improve the technical capacity to solve transboundary socioenvironmental challenges. A week following the declaration, the governor of Ucayali underscored the utility of the workshop by using the workshop maps in a presentation to Brazilian, Bolivian, and Peruvian delegates at a Pan-Amazonian seminar focused on tourism and commerce. A month later, the governor and his Brazilian counterpart in Acre signed the agreement of cooperation formalizing the interchange of geographic data across their shared border.

Sharing Data Across Boundaries

The ability to comprehensively share transboundary data across Amazonian boundaries at the state and local scales is unprecedented and marks a major advance not only for the governments, institutions, and universities involved but also—hopefully—for the indigenous peoples, landscapes, and species in the bioculturally diverse borderlands of Amazonia. Only with improved geographic data and transboundary GIS analysis can policy makers make the best decisions possible to mitigate transboundary threats to the Amazonian rain forest.

About the Authors

David Salisbury is an assistant professor of geography at the University of Richmond, Virginia; honorary professor at the National University of Ucayali in Peru; and member of the United States National Section of the Pan-American Institute of Geography and History. A. Willian Flores de Melo is an assistant professor in the Center for Natural and Biological Sciences at the Federal University of Acre in Brazil. Jorge Vela Alvarado is professor of agronomy and director of the Amazon Borderlands Research Center at the National University of Ucayali. Bertha Balbín Ordaya is professor emeritus of geography at the National University of San Marcos in Peru and a member of the Peruvian National Section of the Pan-American Institute of Geography and History.

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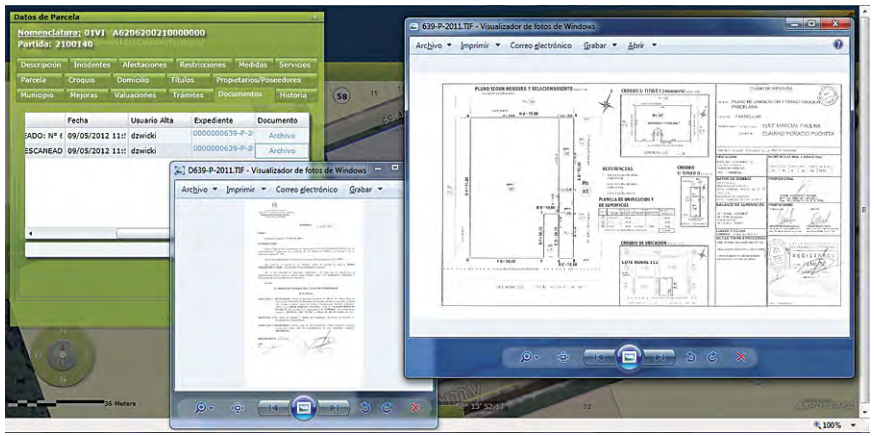
Argentine Land Registry Launches Territorial Information System

The Dirección General del Catastro Territorial (General Directorate of Cadastre Land [DGCT]) of the Province of Formosa, Argentina, is responsible for managing, maintaining, and updating the geographic information and legal valuation of approximately 160,000 parcels that make up the province, contributing to traffic safety, secure land tenure, land-use planning, and urban financing through property taxes. To continue to fulfill these responsibilities, it was necessary to have reliable, high-quality land information that could be accessed easily and efficiently.



The territorial information system's management module links to digital documents, such as these scanned cadastral surveys and the legal document that validates the transaction.

Officials implemented a new GIS to address these needs and realize their vision of having a digital cadastre that is open and allows citizens easy access to the provincial land registry information. This project involved new technological advances within the provincial administration.

Choosing a Partner

Following careful examination of the available options, DGCT (which is integrated with the property registry systems of the Department of Revenue) and the Province of Formosa selected Aeroterra S.A., Esri's distributor in Argentina, to update the territorial information system of DGCT and build a multipurpose, modern, efficient, and web-integrated application linked to other provincial and municipal administrations, allowing graphic and alphanumeric information to be updated and easily accessible to both the public and professionals.

The comprehensive system involves the use of data, geographic databases, technologies, processes, and staff to generate

organizational and interorganizational synergy needed to efficiently manage the new challenges facing modern states.

Updating the Territorial Information System

The main activities included in the updating project were the following:

General Design of the Project—The project design began with a thorough description of the components of the architecture, both software and hardware, as well as the features of each application and the system interfaces. The plan included the migration and integration of data, the training of staff, and change management and implementation strategies.

Administrative Reorganization and Redesign of Processes—Project deliverables included a survey report containing the description, processes, and tasks in each area and a procedures manual with an outline of the proposed procedures, along with the proposed reorganization, justification for the proposed changes, the organizational structure, and job descriptions of each area.

Acquisition of GIS Licenses—Aeroterra S.A. and the Province of Formosa determined that ArcGIS software would ideally suit the needs of the DGCT and the municipalities of Clorinda and Formosa. ArcGIS for Desktop and ArcGIS for Server connected these local governments in an enterprise system to efficiently manage and edit the geodatabase and publish maps.

Information System—The system consists of the following components or subsystems:

- A web cadastral management system to support all the functions and operations performed in DGCT, which has more than 160,000 parcel records and more than 80 jobs
- A consultation and management web system to make available to the community (via the Internet) information residing in the territorial database and facilitate the processing of survey plans by professionals who deal with the provincial land registry (Interfaces will be fully integrated through the Department of Revenue, the Real Property Registration, and Cadastre Municipality.)

Data Migration and Integration—Aeroterra S.A. designed a procedure for migrating data from its existing format to the new geodatabase model based on data migration mapping without generating inconsistencies.

Monitoring and Control—Supervision and quality control of products are supported in SharePoint and the communication protocol designed for this project, speeding up decision making.

The New System Goes Online

The updated Territorial Information System of DGCT was named the Land Information System and was inaugurated and became operational December 2, 2011. The event was chaired by the

minister of economy, treasury, and finance, Ms. Ines Beatriz Vecchietti Lotto. Also participating were the director of cadastre Ruben Dario Mirando Bobadilla, general director of revenue Sergio Rios, and undersecretary of provincial unit systems and information technology Luke Vincent.

"The development of new tools aims to facilitate citizen access to information and also enable the government to make decisions in a timely manner, providing secure data necessary to carry out optimal management," said the minister, who also mentioned the provincial state investment in computer equipment and software and the involvement and commitment of human resources in achieving success in implementing the new computer system.

For more information, visit www.aeroterra.com or formosa.gob.ar/catastro.html. DGCT of the Province of Formosa was a recipient of Esri's Special Achievement in GIS (SAG) Award at the 2011 Esri International User Conference.

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Bolivian Pipeline Company Expands into Mobile Asset Management

Landlocked Bolivia is unique among nations for many reasons, not the least of which is its wide range of terrains, climates, and biodiversity, which are in turn a consequence of precipitous altitude changes within the country. From Andean glaciers to Amazonian rain forests, the country is a patchwork of varying elevations, including dozens of active and extinct volcanoes and innumerable rivers.

YPFBT pipelines traverse the beautiful, expansive, mountainous regions of Bolivia.

YPFB Transporte S.A. (YPFBT) is Bolivia's major hydrocarbon transportation company. YPFBT currently operates more than 6,200 kilometers of natural gas and liquid pipelines throughout Bolivia, many of which traverse geologically active terrain that's subject to landslides and earthquakes.

The pipelines range in size from 4 to 36 inches in diameter. Construction of some of the liquid pipelines dates back to 1955, while some of the gas pipelines were constructed as early as 1968, causing YPFBT to face challenges that typically accompany the maintenance and protection of an aging infrastructure in an inhospitable environment that includes dense vegetation, heavy rains and flooding, and mountainous terrain.

Due to the limitations of its legacy CAD drawings, YPFBT made the decision in 2009 to transition to an interactive, GIS-based mapping system. With this, the company was able to better meet the increasing requirements for data maintenance, mapping and reporting, and integrity management.

The company selected Esri's ArcGIS following a thorough research process.

"It used to take several months of drawing updates and corrections to generate a new set of company operation maps with our old CAD-based mapping system," says GIS specialist Giovanni Rojas, who then explains that with the company's new ArcGIS software-based mapping system and other software, now it only takes a couple of days.

YPFBT has continued to expand on its Esri technology foundation. The ArcGIS Pipeline Data Model geodatabase schema has also proved to be an enormous boost to YPFBT's GIS capabilities, since it was designed specifically for storing information specific to gas and liquid pipeline systems.

Before YPFBT moved to its new mapping system and the In-Line Inspection (ILI) tool, anomalies detected were located by a manual chaining method so the defects could be exposed and repaired.

"Locating a defect this way was inaccurate, labor-intensive, and very expensive," says Juan Hurtado, YPFBT's ILI operations manager, "requiring pipeline maintenance crew members to chain the site and usually several verification digs. Now, with GPS and linear referencing, we can accurately locate the underground pipeline features and defects. This means that when the ILI tool reports a defect, a crew member can easily navigate to the site and locate and mark the position for the excavation crew."

Enhancing Field Data Collection

In 2011, YPFBT was looking for ways to build on the success it had achieved with ArcGIS. The company wanted to enhance the level of detail and integrity of its field asset data collection processes and was looking for a mobile solution that could support complex workflows through standardized forms.

"While collecting burial data for the geohazard risk assessment project, we encountered many undocumented reroutes and emergency works performed by maintenance crews," says Graciela Gutierrez, risk assessment operations manager. "This emphasized the need to add accurate field data collection to our GIS-based mapping system and risk assessment in order to ensure precision and reliability."

The detailed requirements list for the mobile solution was extensive and arrived at through a collaborative and iterative process between YPFBT office and field personnel. The solution had to support ArcGIS for Server. It would have to support relational databases using globally unique identifiers for primary and foreign keys, as well as support Oracle Spatial and SQL Server Spatial databases.

YPFBT also wanted the mobile solution to integrate directly with the ArcGIS Pipeline Data Model because it would enable the company to manage the pipeline data in standardized format. In the end, YPFBT chose CartoPac Mobile from Esri Partner CartoPac International of Fort Collins, Colorado. The solution's

YPFBT's mobile devices exchange asset data with its GIS. Finding the right solution involved many entities within the organization.

GPS-enabled data capture process was designed specifically to map, inventory, and manage field assets with very high accuracy. It allowed field teams to use intelligent, configurable workflow forms running on mobile devices to standardize the asset inventory efforts across all the field teams.

YPFBT began implementation of its mobile solution with a pilot program focused on field data collection related to class location and high-consequence areas. Prior to initiating the 2011 pilot program, YPFBT personnel attended an in-depth training program on the solution to build competence in building, modifying, and managing their own workflow solutions.

The objective of the pilot program was to capture field asset data in two districts over the course of three months, evaluating the solution for accuracy, ease of use, and reliability. The results of the pilot program were a success, and in early 2012, full implementation began. The scalable architecture will eventually support a growing number of mobile users from the Maintenance, Cathodic Protection, and Coating Departments.

YPFBT's expansion into mobile technology was methodical and precise. This extensive, inclusionary selection process resulted in an enterprise approach to defining YPFBT's mobile asset management needs, extending and building on top of the company's GIS system.

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City of Córdoba, Argentina, Modernizes Its Land Registry Administration

Sonia Tobarez and Germán Cacciamano, Local Land Registry, Municipality of Córdoba

Founded in 1573, Córdoba is the second-largest city in Argentina and is home to 1.3 million people. It is located near the geographic center of Argentina, encompassing 576 square kilometers, and its historical and cultural roots are a vital part of the city's character. For example, the National University of Córdoba (founded in 1613 and the first in Argentina) is at the heart of the city's cosmopolitan flair. Economic activity is diversified among the industrial, service, fruit horticultural (the greenbelt of the city), and construction sectors.

Presently, its land registry has more than 480,000 buildings and 68 million square meters. Its annual rate of growth, averaged over the last five years, is 7,300 new buildings and 1.7 million square meters.

The city's Local Land Registry, founded in 1930, is responsible for managing and updating all the geometric, valuative, and legal information for the city's many buildings and contributes to the safety of property trade, ownership of the land, territorial organization, and urban financing through land-related tax.

It is essential for the fulfillment of the Local Land Registry's purposes to have not only quality territorial information but also easy and efficient access to that information. Until 2005, the constraints on information by paper, file drawers, primitive computer maps, and manual processes combined to restrict the registry's ability to overcome new challenges.

The City of Córdoba decided to develop its own land information system on the Esri platform for several reasons—the high quality of its products, corporate management of spatial data, cadastral maintenance tools, and alternatives and possibilities to present maps of the city with high quality and design in both digital and print format. It also provides a single platform with integrated full-featured data management, maintenance, publication, and mass distribution without the need to move between systems, applications, and databases.

Territorial Information Management Before Modernization

The last cartographic work developed by the Municipality of Córdoba was the official map of the city in 1986. After that, there was no training on, or updating of, the cartographic production tools.

A deeds register was made with the same techniques used in 1940, when the first cadastral maps, detailed by block, were

drawn. Many of these documents were still used, and although data maintenance continued, the register was unconnected, the documents showed isolated sections of the city that were often difficult to join, and the manual process did not allow staff to guarantee quality of data. The model and updating techniques were deficient for the city and its challenges and demands.

Land Registry Modernization

In December 2005, a project was begun to systematize the management of cartographic information with a view toward complete modernization of the Local Land Registry. This project had the financial support of the Inter-American Development Bank (IDB). Activities included supplying computers, printers, plotters, and GIS software (ArcSDE and ArcIMS) and consulting services for the implementation of specific work and training.

The project focused on incorporating the great amount of existing graphic data and implementing it in an environment based on GIS technology, working with a single database on which data maintenance, cartographic printing, consultation, and land administration will run simultaneously. The first stage, lasting until the end of 2007, focused on database development, digitalization and integration of information, development of custom functionalities in ArcGIS for Desktop, and development of capacities in the organization. The second stage, without the financial support of IDB and run by trained staff from the municipality, focused on data reorganization; increased process quality; and distribution of information, mainly through a web application based on ArcGIS for Server.

Aeroterra S.A., Esri's international distributor for Argentina and Uruguay, located in Buenos Aires, Argentina, was key to the product's implementation, because it provided the necessary specialized support and the formation of principal human resources, both in administration and data maintenance, on the application development. It was also responsible for GIS software training. Courses and practices were carried out through an inductive courses system, with GIS management and development technologists in the company training center following the in-company model, which turned out to be extremely profitable for the municipality.

The municipality considers the cost-benefit ratio very positive. IDB's total investment was US$340,000, which accounted for 75 percent of the funding, the remainder being the municipality's own resources for satellite images and regularization of informal settlements. The involvement and commitment of the organization's human resources were key to the achievement of success in the reform.

Management, Maintenance, and Distribution of Territorial Information

Database design was guided by the directives of Catastro 2014 (FIG, 1998) and, in conjunction with a participatory process,

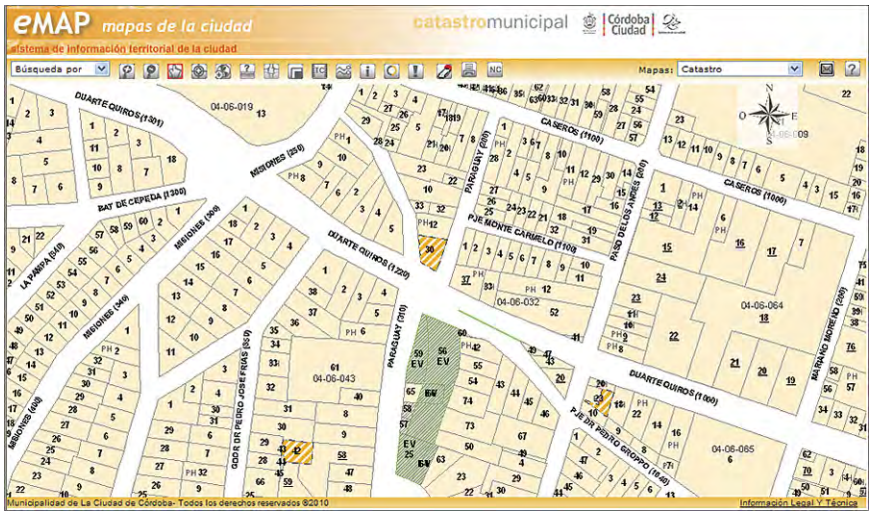
helped staff achieve a solid database with current and future needs identified.

The current database is georeferenced in the official system of Argentina and has all the deeds register's data (plots, plot boundaries, possessions, expropriations, width of public streets, etc.); land values (block by block); administrative divisions; natural features; urban nomenclature (addresses, appropriate for geocoding); relevant facts (drawings that have not been approved and irregular division of plots); more than 30,000 scanned maps (cadastral and topographic); and three orthorectified, high-definition satellite images (IKONOS 2005 and QuickBird 2007 and 2009). The model has more than 30 objects (types), about 200 descriptive data attributes, and a size of 40 GB.

It is implemented in a geodatabase on ArcSDE 9.3 and SQL Server 2003, running on an IBM server, with four Xeon (dual core) processors with 3.16 GHz, 4 GB of RAM, a RAID SCSI mirrored disk of 140 GB, and one nonmirrored disk of 280 GB.

Another important aspect was map design, for which Esri products offered versatile and professional solutions. More than 60 standard maps based on layout view were produced, allowing changes only on feature content and location within the city, with preestablished scales to achieve uniformity in print output and PDF documents.

The content of each map comes from the geodatabase, which is permanently maintained, so that all the information provided by the Local Land Registry is up-to-date, allowing a high-quality service. This updating requires a commitment to continuous training of GIS professionals and staying on top of innovation of Esri products used. In updating, six technicians use ArcGIS for Desktop Advanced and ArcGIS for Desktop Standard licenses, working on a database versioned in multiple editing sessions, which allows editing without blocking the functions of the production version or impact on other users. The GIS staff is complemented by two developers and one geodatabase administrator.



One of the main products developed in the second stage was eMAP, a powerful web system of territorial information management based on ArcGIS for Server, which more than 500 internal users work with daily.

eMAP

One of the main products developed in the second stage was eMAP, a powerful web system of territorial information management based on ArcGIS for Server, which more than 500 internal users work with daily.

The data access diagram is complemented by ArcGIS for Desktop clients; AutoCAD clients through ArcGIS for AutoCAD; and other GIS clients, such as open source gvSIG, through a web map service.

The eMAP system has a wide range of functions, such as getting cadastral information through multiple searches; cadastral management tools, including reservation of the nomenclature; different map services (public lighting, private works, official plan of Córdoba, values map); the ability to report incidents and choose the quality of output maps; and links that associate the map with the bank of scanned maps.

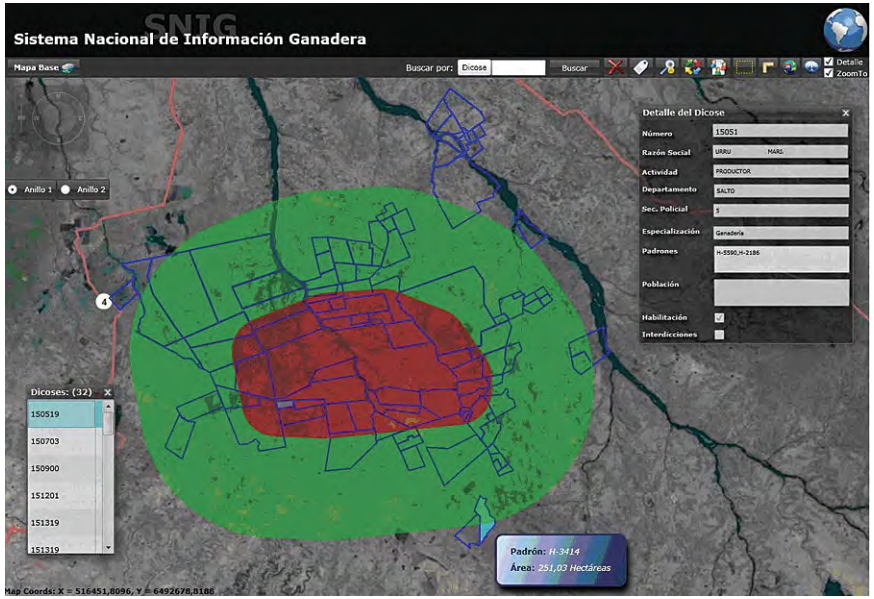
About the Authors

Sonia Tobarez, information system engineer, has been a professional in the GIS area of the Local Land Registry Department, Municipality of Córdoba, since 2004. Germán Cacciamano, a survey engineer candidate, has been a GIS professional in the cartographic area of the Local Land Registry Department, Municipality of Córdoba, since 2004.

(This article originally appeared in the Spring 2012 issue of *ArcNews*.)

Uruguay Streamlines Livestock Traceability

Pablo Rebufello, Pablo Piperno, and Gustavo Drets



Result of two distance searches for neighboring lands of a farm. A sanitary emergency is one of the possible uses for this tool. In the picture, neighbors pertaining to the first ring are shown. Note that when a farm has lands within the red ring, all its parcels are shown, even if they fall outside the ring.

Uruguay is a small country of three million people and more than 11.5 million livestock. Eighty-five percent of its surface area is devoted to grazing. The quality of its livestock and its exceptional sanitary conditions, as well as its derived products, have allowed the country to earn a place among the major exporters of the world.

The Ministry of Livestock, Agriculture and Fishery (MGAP) of Uruguay created the National System of Livestock Information (SNIG), a multipurpose system that gives support to operational and strategic decisions for this important branch of the economy. SNIG was developed for tracing livestock. This traceability system, which is compulsory and has national scope, encompasses more than 75,000 participants in the agricultural and industrial sectors, including all the breeders, intermediaries, livestock auction locations, and slaughter plants in the country.

In a gradual process that began with the individual radio frequency identification (RFID) and registration of all calves born after 2006 and culminated in July 2011 with the identification of the rest of the livestock population, SNIG incorporated more than 11.5 million animals in its database, making Uruguay so far the only country with full livestock population traceability.

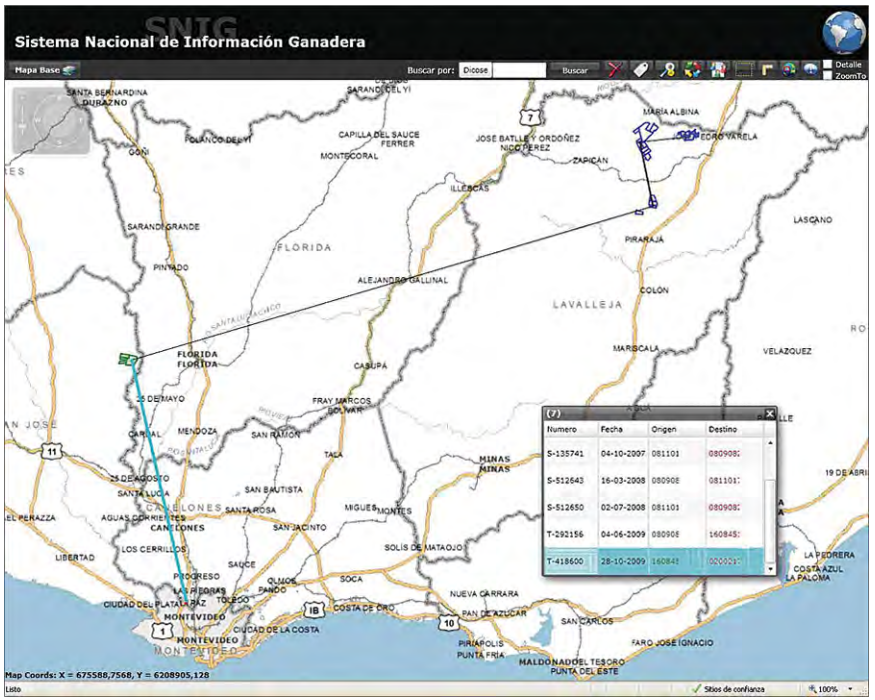
Each livestock transaction, both by transportation and ownership change, must be preauthorized and recorded in real time. This allows SNIG to receive information about 350,000 operations carried out annually, verify that the actors are registered and

do not have any sanitary or legal prohibitions, and establish and register the origin and destination of each movement. This information is stored in a centralized database and managed through a web portal either from different offices of MGAP distributed throughout the country or from the farms, possible because most of the country has 3G/GPRS coverage.

A traced calf, showing the RFID tag.

In short, this allows SNIG to store updated data on each bovine animal in the country—who the owner is, where the animal is, where it was, and if it was in contact with other animals—from birth until it is sent to slaughter.

SNIG was designed by a consortium of companies, including Ingenieros Consultores Asociados (ICA), a GIS company and Esri international distributor. ArcGIS for Server was chosen as the technology platform because it provides the functionality to handle a significant amount of data that can be easily integrated in web solutions of the system. ArcGIS API for Silverlight 2.1 proved to be an excellent development platform for this application. In other words, for the huge volumes of data



Path of an RFID-identified animal. Each line segment shows a different transportation of the animal.

involved, ArcGIS for Server was the perfect solution due to its horizontal and vertical scalable architecture.

To obtain geographic data providers, agreements were established with the Uruguayan Spatial Data Infrastructure Commission and other institutions. The General Directorate of the National Cadastre provides GIS information for 200,000 rural parcels. Additionally, the Ministry of Transportation provides GIS information concerning roads, administrative divisions, locations, and 20 other layers of reference.

The developed web application gives different involved actors (breeders, brokers, industry, veterinarian services, police, etc.) information related to their activities, providing transparency to the system. Each participating actor has different privileges that give authorized access to distinct data and functionality. For example, breeders may access maps of their farmlands and data on activities or animal species through their respective registration numbers. Veterinarian services may access maps showing rings of neighboring farms, data used in case of animal diseases.

The quality of services and increasing development have enabled SNIG to fulfill an important role in the construction of an integrated vision from both external and MGAP information systems.

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