GIS Best Practices

Sustainable Development Volume II

November 2010

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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 U.S. Census Bureau to add data layers to a map that shows residents' education levels, ages, and employment status. With an ability to combine a variety of datasets in an infinite number of ways, GIS is a useful tool for nearly every field of knowledge from archaeology to zoology.

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

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

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

Rosario C. Giusti de Pérez Brings Urban Planning to the Slums of Venezuela

The United Nations Center for Human Settlements reports that more than one billion people in the world live in slums and squatter settlements without adequate shelter and basic services. Worldwide, slums are considered to be residential areas in urban geographic areas that are inhabited by the poor. Because of these characteristics, urban planners can use GIS to manage geographic data about slum areas to show relationships, elevations, landmarks, slope, water sources, and other attributes that affect these urban populations.

Rosario C. Giusti de Pérez.

Rosario C. Giusti de Pérez, architect and urban designer, exemplifies the importance of combining the human element of concern with the capabilities of technology to turn the tide of despair to one of hope and benefit for the community. Because of her many years of commitment to helping improve the quality of life in the slums (barrios) of Venezuela, Esri recognizes Rosario C. Giusti de Pérez as a GIS hero.

Despite the fact that Venezuela is an oil rich nation, approximately 50 percent of its people live in poverty. Those in urban areas have constructed shantytowns with homes made of plywood, corrugated metal, and sheets of plastic. Giusti de Pérez does not see these neighborhoods as targets for the bulldozer but rather as communities whose residents need to be involved in planning and redevelopment.

Many cities do not consider these squatter lands as communities and consider demolition to be a solution to urban blight. But this ruthless approach of displacement creates disorder, increases crime, and adds to the misery of poverty. A slum is more than corrugated tin and plastic; it is human faces, neighborhoods of people with social structures that protect and support their communities. Giusti de Pérez has spent the last 10 years working with people and using GIS as a means to understand how urban squatter developments are organized, which in turn offers the foundation for devising improvement efforts.

"When visualizing squatter developments as cities within cities, GIS helps us see the internal connections that constitute the barrio's underlying order, which is fully perceived by the residents of the area," notes Giusti de Pérez. "To fully understand social networks within a community, planners need to obtain information directly from the community. Inhabitants have knowledge about who belongs to each social group and how social groups connect. This is valuable data with a geographic element."

Giusti de Pérez advocates an approach that recognizes the slum inhabitants as being deeply rooted in their communities. As people who have a sense of belonging, they are territorial and fear relocation plans. People want to remain where they have their social relations. Giusti de Pérez, who holds a master's degree in urban design, initiated an approach to developing urban planning models that includes input from residents so that squatter settlements can become an asset to the city. "We need to collect information that is significant to residents," says Giusti de Pérez.

With this thought in mind, Giusti de Pérez developed a framework for sustainable improvement planning with the ultimate goal of advancing the residents' quality of life. The objective of this planning approach is to introduce what she calls "friendly interventions" into the as-built environment. In this model, residents agree on behavioral and building rules, such as sharing waste disposal to maintain clean open space and limiting building height so as not to impede natural light. These are simple resolutions. Of course, squatter communities have much more complex issues, such as unstable slopes, inadequate utilities, and insufficient schools. GIS allows planners and residents to visualize the answers to the questions they are asking: What would happen if we put a concrete fascia on the slope? How can we run sewers into this area? Where is the best location for an elementary school?

Barrio Los Claveles, Maiquetia, Venezuela, seen in ArcGIS 3D Analyst.

Giusti de Pérez uses GIS to create what-if scenarios and generate maps that show what a concept would look like, whom it would affect, and how it would help. These images go a long way in providing information that engenders community participation in planning.

The maps that Giusti de Pérez and Ramón A. Pérez, a GIS professional, were creating in the 1980s using Esri's ARC/INFO began to be noticed. These GIS maps were instrumental in winning several national competitions against other urban planners who used CAD. Soon, several Venezuelan government institutions recognized that GIS is a clever tool.

"Barrio analysis is very complex," explains Giusti de Pérez. "GIS can take this mess of barrio data and organize it into something that makes sense. We would select a barrio, meet with its community leader, and explain that we wanted to help. The community leader would then invite other people from the community to a meeting, sometimes at a school or sometimes just on a slab made of some odd building materials. Together, we would identify what they needed and prioritize their concerns."

GIS was key to a three-year project in the barrio of Petare in Caracas to visualize and assess the area's urban built conditions and social networks. It proved essential to creating a sustainable planning strategy and for designing a development that fit both building and social needs within the conditions dictated by the geography of the site. With an ultimate goal of improving the quality of life, the urban planners worked with residents and identified 93 sectors within 82 hectares. Data included vehicular and pedestrian pathways, sector boundaries, social spaces, and built places. The group determined areas that were at risk for landslides and focused on building control policies for these areas.

Community concerns varied. In the Petare barrio, the community's main concern was accessibility to urban facilities and infrastructure. Residents wanted better drainage and solid-waste disposal. Priorities that were included on another barrio community's list were drainage, open space for children, and lighting. Each project was unique.

"Sometimes we can do a little and sometimes more," explains Giusti de Pérez. "We make our presentations using GIS, and people are glad to see what their community looks like. We use the ArcGIS 3D Analyst extension to create visualizations that show residents what their community could look like if they implemented changes. Based on community input and planners' assessments, we created site analyses that helped communities successfully request government program funding."

Proposed infrastructure systems for barrio Petare.

In 2008, Giusti de Pérez coauthored the book *Analyzing Urban Poverty: GIS for the Developing World,* published by Esri Press. In it, she and Ramón A. Pérez offer a step-by-step approach to working with squatter communities and improving their neighborhoods. The authors provide several rules for using GIS to support sustainable communities. One rule is to create procedures for involving communities in collecting the information required for identifying their problems and opportunities. This will help planners with the problem of lack of data. Another rule is to identify the social relations and interactions of the populations with the open spaces in the community. This is more important than merely describing land use. Finally, the authors advise using ArcGIS Spatial Analyst ModelBuilder in hilly squatter developments to understand the rules of urban and social functioning and identify steep slopes, drainage patterns, and accessibility from the neighborhood to the city.

Giusti de Pérez is hoping to expand the use of GIS models for urban redevelopment and promoting its capabilities to identify real, sustainable solutions for improving the quality of life for millions. She is truly a GIS hero.

(Reprinted from the Spring 2010 issue of *ArcNews* magazine)

The UN's Global Urban Observatory

GIS Promotes Socially and Environmentally Sustainable Habitats

Highlights

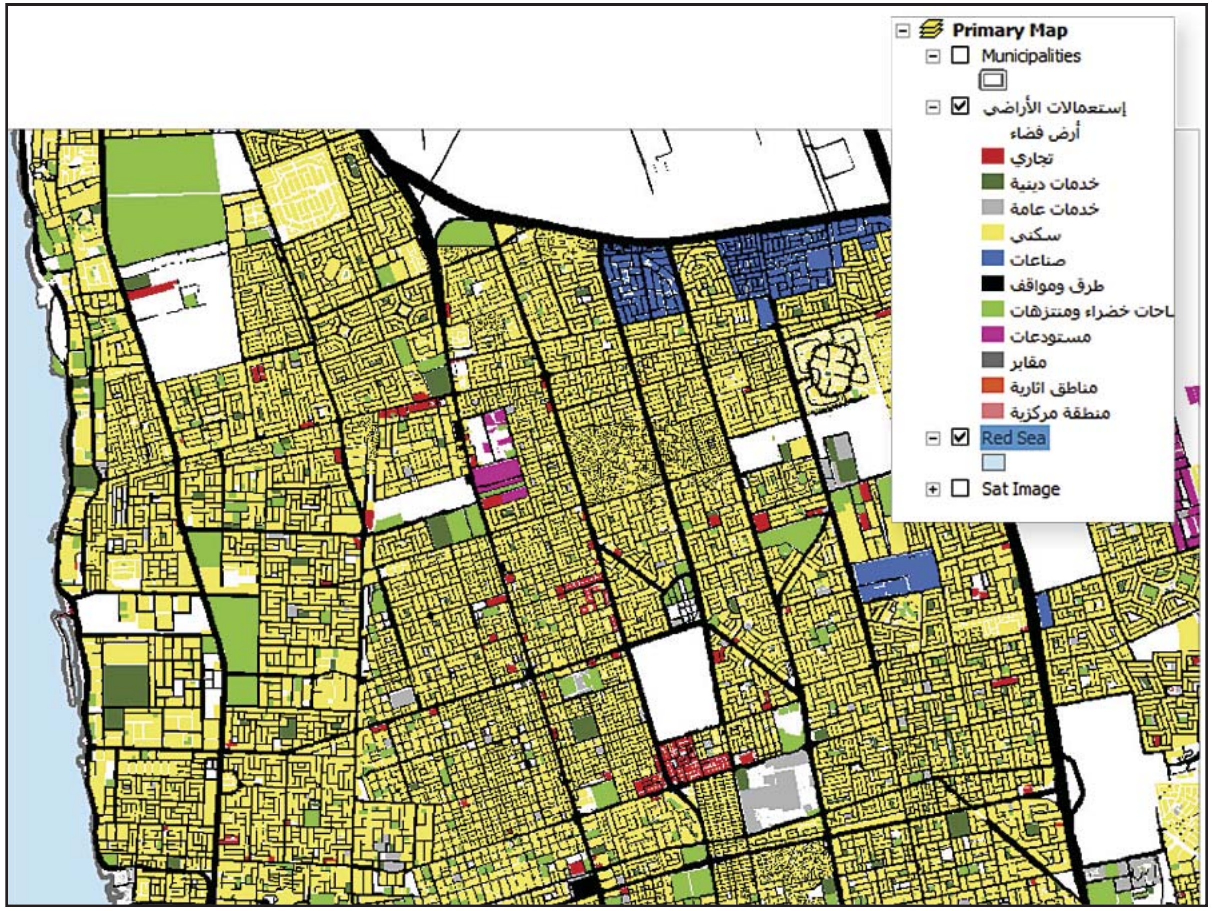
- Observatory monitors urban indicators.
- Policy makers use GIS to meet sustainable city objectives.
- UN-HABITAT adds urban observatory to Good Practice list.

In the last half century, the human population has grown at a phenomenal rate, leaving many of the world's cities bursting at the seams and often without the resources to care for their residents. From 1950 to the close of the century, earth's human population doubled. The United Nations (UN) estimates that one-half the world's population (an estimated 6 billion people) lives in cities and predicts that by 2050, two-thirds of the world's population will live in cities. It also notes that 50 percent of these urban dwellers live in slum conditions with little access to shelter, water, sanitation, education, or health services.

Because sustainable urbanization is one of the most pressing challenges facing the global community in the 21st century, the United Nations launched the United Nations Human Settlements Programme UN-HABITAT. Its aim is to help policy makers and local communities find workable and lasting solutions for developing human settlements. UN-HABITAT promotes socially and environmentally sustainable towns and cities with the goal of providing adequate shelter for all.

UN-HABITAT is building a worldwide urban knowledge base via its Global Urban Observatory that will make it possible to monitor and evaluate urban conditions and trends. This global endeavor is supported by a network of local urban observatories, which are designated workshops that develop monitoring tools used for urban policy making. GIS is proving to be a useful technology for monitoring economic, social, and environmental development.

The Kingdom of Saudi Arabia's cosmopolitan city Jeddah Municipality launched Jeddah Urban Observatory (JUO) to provide information for planning and policy making. Esri Lebanon sal, Esri's distributor in Lebanon, designed a geospatial solution, built on ArcGIS, that improves the urban knowledge base by providing policy-oriented urban indicators, statistics, and other urban information.



This map shows land use in Jeddah City, Kingdom of Saudi Arabia.

Dr. Mohamad Abdulsalam, Jeddah Municipality's JUO chief supervisor and assistant to the deputy mayor for Environmental Affairs, notes, "The primary goal of building a GIS-based urban observatory is to use current data and ICT [information and communication technology] to effectively and efficiently disseminate among concerned decision makers and stakeholders information, knowledge, and expertise about a city's most current urban indicators, statistics, conditions, and profiles."

Staff can easily use JUO's GIS tools for spatial manipulation, simulation, and analysis and to display urban indicators. These indicators have spatial dimension. Indicators include variables of poverty, environmental degradation, provision of urban services, deterioration of existing infrastructure, access to secure land tenure, and adequate shelter. To date, JUO has generated 80 urban indicators and plans to define and generate 200 more.

The information technology infrastructure that supports JUO consists of two high-specification servers, 10 PCs, a local area network, and a high-speed DSL Internet connection. The GIS comprises ArcGIS Desktop and ArcGIS Server software. Through the use of Web-based GIS applications, JUO indicator data can be accessed and benchmarked at regional, national, and global levels. JUO has become the most important source of socioeconomic data in Jeddah.

GIS outputs help staff target need, monitor urban inequalities, assess the distribution of services, identify trends, and target resources for more effective allocation. For example, an adult illiteracy thematic map shows the percentage of male and female adults above the age of 15 who are illiterate. A transportation model displays various transport types within Jeddah's districts. A population density indicator map applies dots and graduated colors to show the population distribution across the city's districts. Although the GIS-based solution delivers advanced results, its tools are user-friendly, so it can be easily adopted by other Arab urban communities.

UN-HABITAT recognized Esri Lebanon's JUO project by adding the unique information and monitoring initiative to its Good Practice list for cities to assess, identify, and monitor urban conditions. The performance of JUO is being monitored by His Highness Prince of Makkah Region as well as by Jeddah's mayor and municipality officials. "Jeddah citizens are truly the main beneficiaries of the project," concludes Manal El Sayed, Esri Lebanon's GIS solutions manager, "as analysts and policy makers assess the extent of the city's problems and design the policies and interventions needed for achieving sustainable urban habitats."

More Information

For more information, visit Esri Lebanon at www.esrilebanon.com.

(Reprinted from the Spring 2010 issue of *ArcNews* magazine)

MapAction Awarded for Applying GIS to Humanitarian Aid

During the User Conference Plenary Session, Esri president Jack Dangermond presented the Humanitarian Award to MapAction, an organization that helps governments and relief agencies coordinate aid and relieve human suffering. In his speech of thanks, MapAction chairman and volunteer Andrew Douglas-Bate praised Esri for its help to the charity by providing software and software maintenance. The brainchild of his son Rupert, founder emeritus, MapAction is feisty, driven, and just 13 years old.

MapAction has completed approximately 80 GIS deployments, 16 of which have been in response to catastrophes, such as earthquakes, hurricanes, tsunamis, floods, or volcanic eruptions. The charity also uses GIS to respond to man-made crises, giving aid such as mine clearance or refugee movement. Other missions to help the human condition and design our future include teaching local communities how GIS works and how it can be used both as a first step and as disaster develops.

"We aim to help people to help themselves," said Douglas-Bate. "The power of GIS is step one in that equation. The first few hours after a disaster are crucial to saving lives. The disaster level and comfort of those in need have to be addressed with speed and effectiveness in situations where the whole landscape may have changed. A fog of uncertainty hangs over the scene of catastrophe. This is where GIS, arriving within hours and in the hands of highly trained, highly motivated, well-led MapAction volunteers, transforms humanitarian aid opportunity into delivery success."

When asked about financial support, Douglas-Bate said, "The MapAction service is free to recipients. While we rely on practical and technical help from organizations like Esri, we also depend on external funding from many sources. Several types of funding are required such as endowment sums for long-term infrastructure and specific project funding. The more we receive, the better we are able to serve our critical clients. I want to thank many users for their contributions. For example, a schoolteacher from Palm Beach said she would go home after the User Conference and raise hell with the local community to get money for us. We take away from San Diego an exciting GIS message, not only of what is happening today but its potential for the future of our planet."

For more information, visit www.mapaction.org.

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

Rebuilding after a Disaster

Aceh Province, Indonesia, Continues GIS Work Five Years after Tsunami

By Karen Richardson, Esri Writer

Efforts continue to supply aid to the victims of last January's earthquake in Haiti and to rebuild the homes, roads, and other damaged infrastructure. Several organizations are using geospatial technology to obtain supplies and food, assess damage, and start to reconstruct. (Learn more about how Esri is supporting these organizations' efforts.)

The article below details how GIS was used in Indonesia after a disaster of similar magnitude.

Five years ago last December, on the day after Christmas, a magnitude 9.1 earthquake in the Indian Ocean set off a devastating tsunami. From the beginning, GIS played an important role in mapping the impact of the disaster, guiding emergency responders to the devastated areas, and coordinating the relief effort. Now the technology is being used in the process of rebuilding.

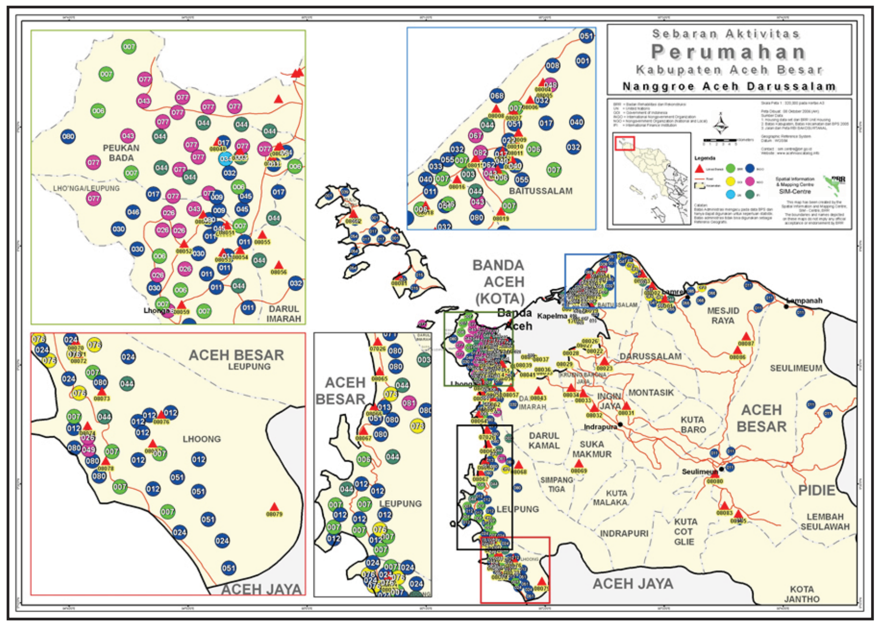
The tsunami in Southeast Asia ripped apart boats, roads, and buildings.

Waves of up to 30 meters high struck Southeast Asia during the tsunami. Almost 230,000 people in 14 countries lost their lives. But most of the damage was centered in Aceh province on the northern tip of Sumatra. The coastal region was leveled. Water rushed inland as far as four kilometers, in one instance carrying with it a 2,600-ton barge and depositing it to languish as a reminder of what had happened. Services and infrastructure throughout Aceh province were severely impacted. Water, sewer, and electrical systems were destroyed and had to be reestablished. Even transporting supplies and the labor force to the affected areas was hampered, because every single road along the west coast had been severely damaged or completely washed away in large sections.

Seeing the region today, little evidence remains of the devastation, as Aceh continues to not only recover but also, as the government's motto says, build back better.

International Aid Agencies Rely on GIS for Fast and Efficient Emergency Response

The United Nations brought in GIS technology to assist in rebuilding Aceh. The Indonesian government and more than 65 nongovernmental organizations relied on the technology to help facilitate relief efforts, strategize management of health care, and begin to rebuild infrastructure. The organizations used GIS to produce maps for humanitarian work, including maps of injured populations, damage assessments, and displaced persons. Among the most valuable products that UN HIC produced was a map of where each organization was working, so information could be communicated quickly to relief workers scrambling to aid those affected by the devastation. Today, GIS continues to help Aceh province manage assets, reduce illegal logging of the Sumatran forests, and incubate new industries such as tourism.

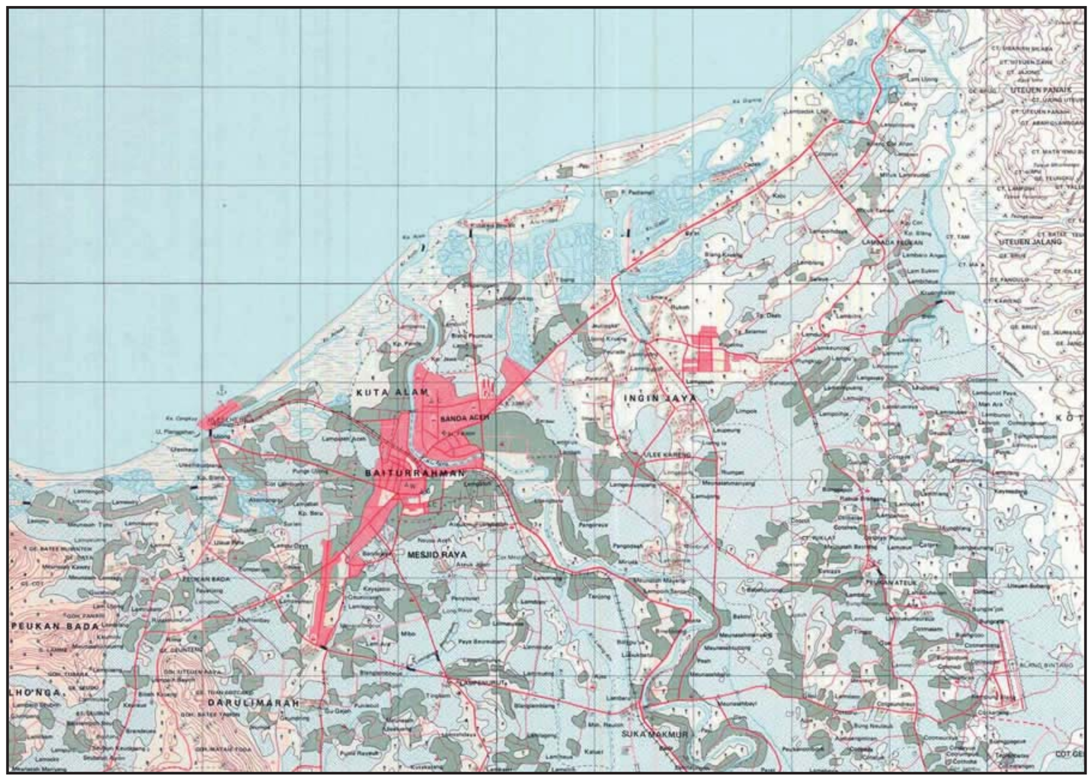


Among the most valuable products the UN HIC produced was a map of where each relief organization was working after the tsunami. That information could be communicated quickly to relief workers scrambling to help people affected by the devastation.

Today, GIS continues to provide necessary insight into the information that helps Aceh province manage assets, reduce illegal logging of the Sumatran forests, and incubate new industries such as tourism.

To begin coordinating the relief effort, emergency responders needed to be guided to areas damaged by the tsunami. Maps were required to visualize where supplies should go and which organizations would be able to assist.

Since the tsunami tore up the shoreline, it was a challenge to find current and accurate geographic data for the region. The national mapping agency Badan Koordinasi Survei dan Pemetaan Nasional (Bakosurtanal) provided 1:50,000-scale maps, but what remained of the mapped infrastructure for the province was not always up-to-date.



1:50,000-scale maps were available, but the tsunami rendered many of them out-of-date.

"Unfortunately, disasters happen when we least expect them," said Erik van der Zee, GIS adviser for the spatial planning and environmental management component of the Earthquake and Tsunami Emergency Support Project (ETESP). The ETESP is supported by the Asian Development Bank (ADB).

"This emergency really exemplified the importance of countries investing in national mapping agencies to provide the information necessary to respond to catastrophes such as this," van der Zee said.

Where maps were rendered useless by either changed infrastructure or the tsunami's impact, the United Nations Humanitarian Information Centre (UN HIC) turned to high-resolution satellite imagery to supplement the vector base data. Since a complete image of the area was unobtainable due to heavy cloud cover, older topographic maps were also scanned.

Satellite Imagery of the Changed Coastline.

Days after the tsunami, the UN set up HIC. Based in tents at the heart of the catastrophe, HIC collected data from the Indonesian government, nongovernmental organizations (NGOs), and international agencies. UN HIC delivered GIS data and maps to the responding humanitarian community, allowing workers to deliver assistance more effectively immediately after the emergency.

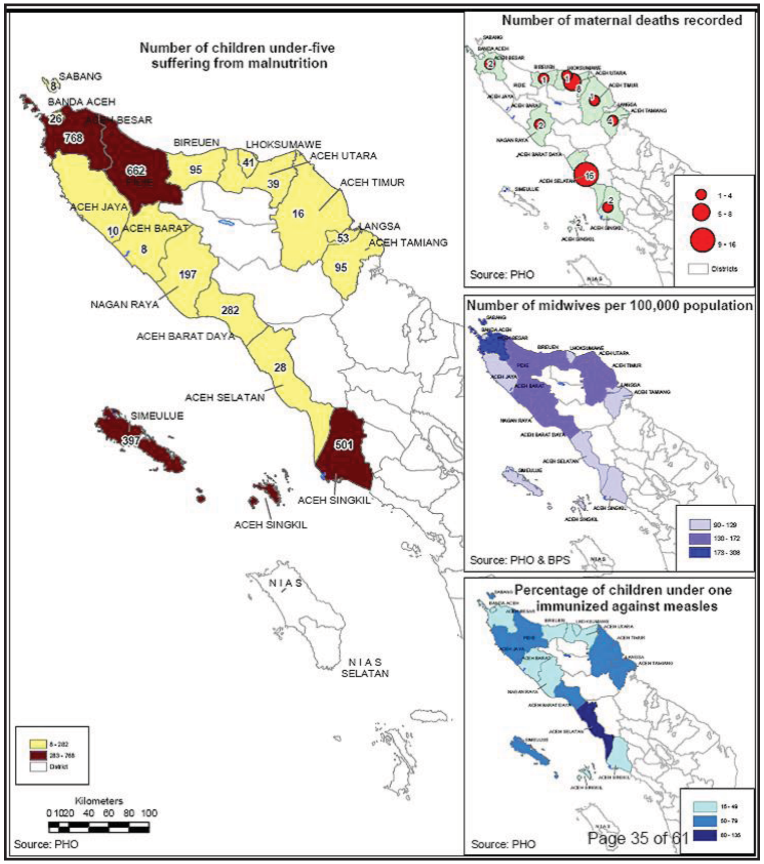
GIS Used during Tsunami Disaster Response

Apart from providing informative topographic maps to coordinate relief efforts, GIS was used in specific sectors during the initial response to the disaster.

Health

The most immediate concerns were to contain disease outbreaks and prevent more people from dying of starvation. Officials needed to know the location and number of survivors, as well as the extent of their injuries, to provide them with food, water, and medical supplies.

The UN HIC team, working with the UN World Health Organization (WHO), collated and evaluated data using GIS to create an accurate picture of the damage and prioritize needs. Activities were coordinated and prioritized; field hospitals and mobile health clinics were set up where needed. No major outbreak of disease occurred. There were few deaths, contrary to expectations after a disaster of this magnitude.



UN HIC worked with the World Health Organization to collect and evaluate data, using GIS to create an accurate picture of the damage and prioritize need.

Mobile Resource Planning

Since the main west road and all seaports in Aceh province were unusable, transporting food, water, and medical supplies seemed nearly impossible. GIS was used to route trucks and prioritize shipments.

Infrastructure

Many groundwater reservoirs were polluted, sanitation at temporary shelters was an issue, and drinking water had to be trucked in to the area. GIS was used to identify risk areas and develop management plans.

GIS was used to route trucks and ship goods efficiently throughout the region. (Credit: Joerg Meier, Aceh Besar)

GIS was an invaluable tool in planning the infrastructure repair work.

Education

Since 50 percent of the schools in Aceh province were damaged or destroyed, GIS was used to decide where best to build new schools based on population density and proximity to health facilities. Damaged facilities were assessed to identify which schools could be rebuilt more quickly.

GIS maps helped agencies rebuild and repair more than 100 education facilities in the region, allowing children to return to school.

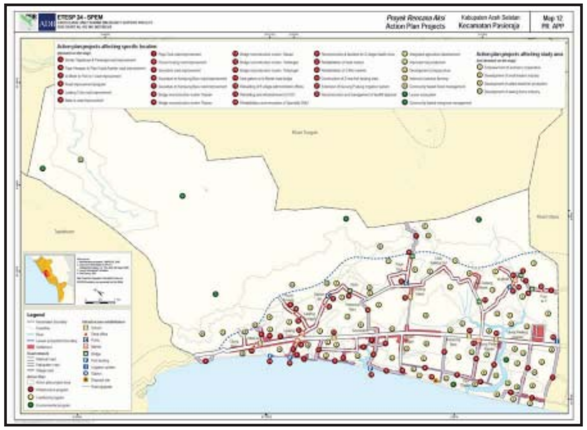
Housing

The simple act of providing shelter presented many challenges. More than a half million people were left homeless when land washed away and traditional landmarks vanished. Land that remained had to be cleared of millions of tons of debris and silt before it could be used again, and many areas were no longer suitable housing locations.

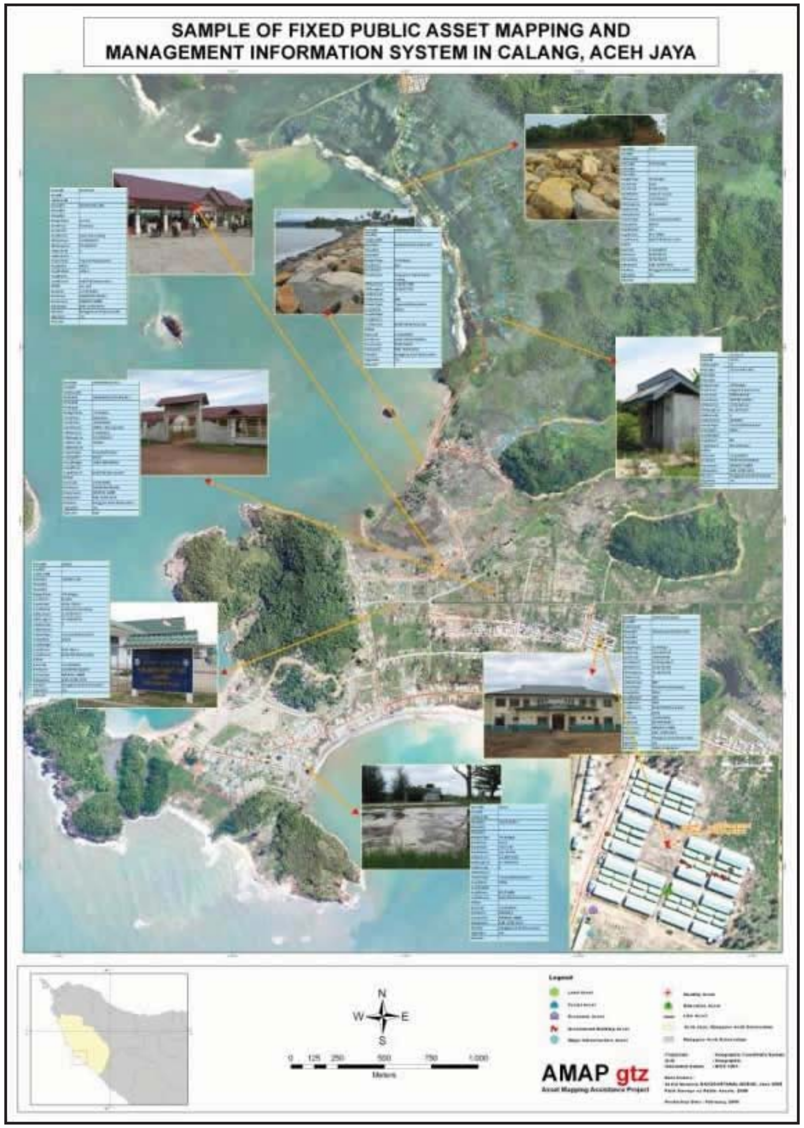
Workers from the international aid community went into the field to map where houses once stood and determine who owned the properties. Pseudo land titles were issued with the signatures of all neighbors and the village leader.

Initially, there was no mandate to coordinate rebuilding among the various agencies. Government staff used GIS to coordinate activities including spatial planning, village mapping, community planning, engineering design, and house building.

NGOs and the government worked together to rebuild Aceh's infrastructure, from houses to schools, hospitals to markets, and roads to bridges. Together, using GIS, the organizations made collecting, managing, and sharing information as timely as possible between many different stakeholders.



A sample map displaying infrastructure, livelihood, and small environmental projects was developed from field surveys, by talking to community members and analyzing spatial data.



Australian Government Overseas Aid Program (AusAID) funded the Asset Mapping Assistant Project (AMAP), which is managed by GTZ. AMAP facilitates the allocation of scarce resources and manages public assets.

"As a result of the GIS data collection and compilation during the past five years of reconstruction, this area may be considered one of the richest provinces in terms of spatial data and information in Indonesia," said van der Zee.

Today, GIS and geospatial data is managed by the Aceh Geospatial Data Center (AGDC) of the Provincial Development and Planning Board in Aceh (BAPPEDA) and the governor's office. Yakob Ishadamy manages the AGDC. He managed the GIS work during the initial recovery. GIS centers have been established in six districts in Aceh province and are able to do basic GIS processing. GIS data is maintained with Esri GIS software and is available in shapefile format.

"GIS continues to have a role to play by providing information to government officials and others to support their efforts," said Ishadamy. "The reconstruction, economic, and social factors involved all have a time-and-space component. GIS provides an invaluable framework for building an information base and providing the best decision support, communication, and collaboration possible."

(Reprinted from the March 2010 issue of *ArcWatch* e-magazine)

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.

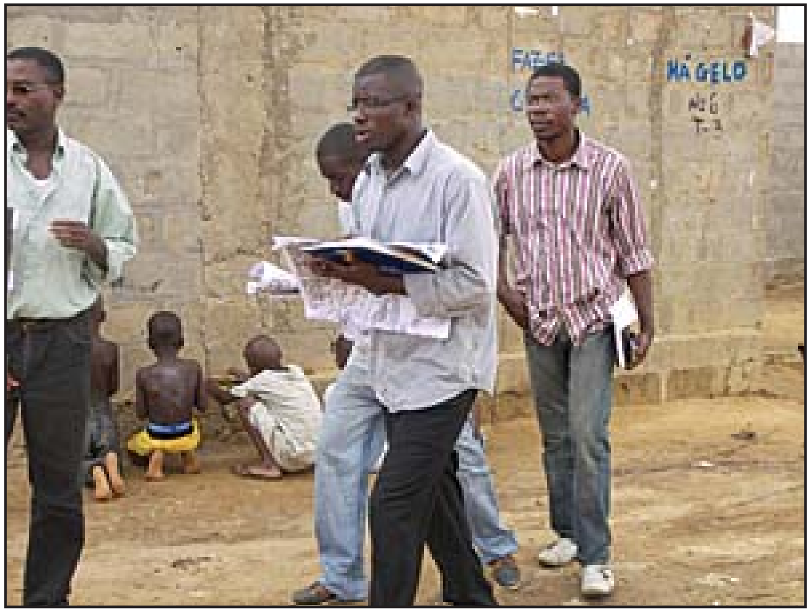
To address this need, the Academy for Educational Development (AED), a leading nonprofit organization working globally to improve education, health, civil society, and economic development, is working with Empresa Distribuidor de Electricidade (EDEL), Angola's national electricity distribution company, 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.

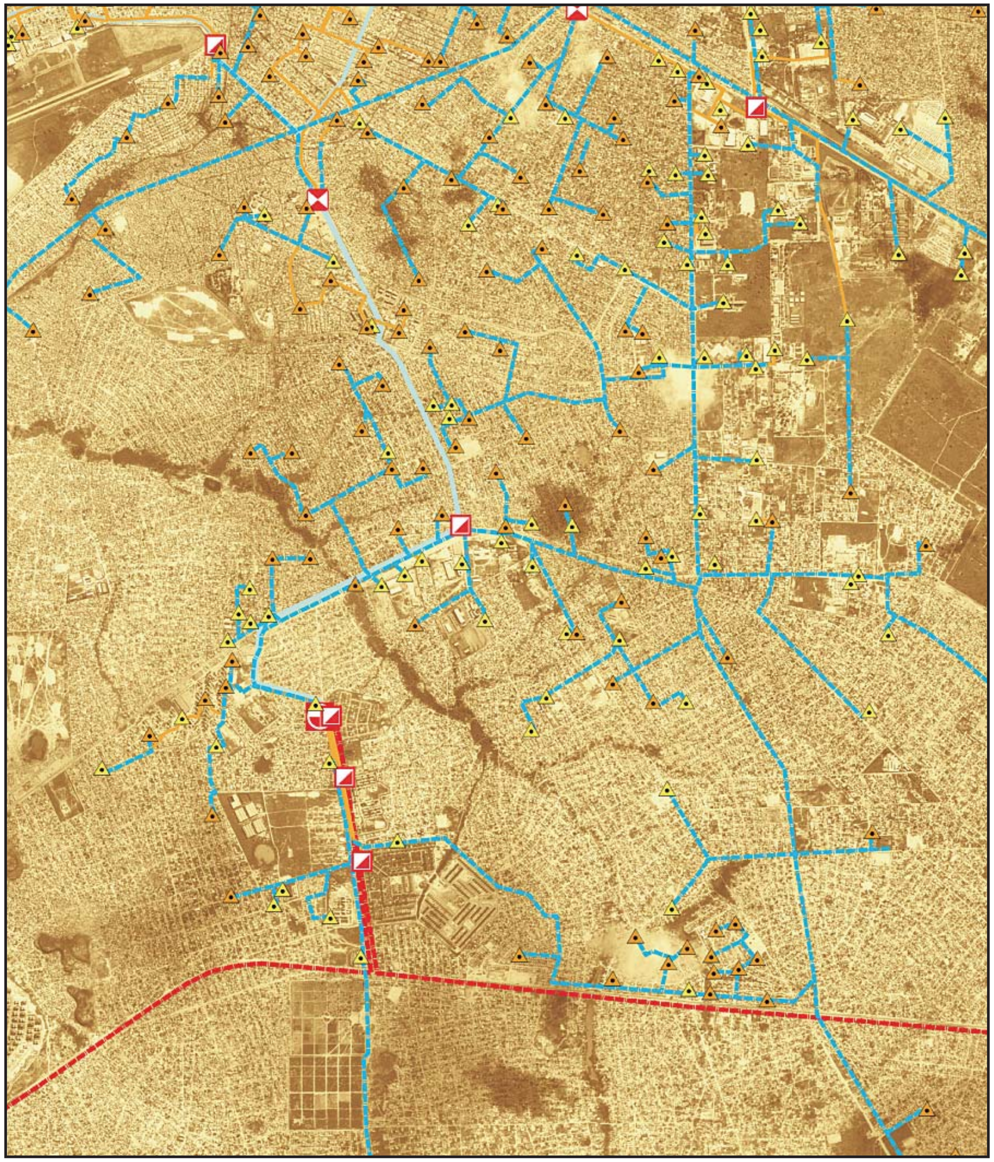
"Providing electricity to homes and businesses requires more than just installing poles and stringing cable," says Joao Baptista Borges, the chief executive officer of EDEL, which provides service to more than 7 million people in and around Luanda. "Maps, census, customer, and infrastructure data—which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



Surveyors in Kilamba Kiaxi map the municipality.

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.



Electricity network in the municipality of Kilamba Kiaxi, Luanda, created in GIS.

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

(Reprinted from the Winter 2009/2010 issue of *ArcNews* magazine)

Ghana Project Leverages GIS-Based Title Registration and Microfinance to Alleviate Poverty

By Peter Rabley, International Land Systems, Inc.

Highlights

- The project was presented to the United Nations Commission on the Legal Empowerment of the Poor.
- System incorporates ArcGIS functionality to link title information with the digital parcel map.
- Title and parcel data for loan processing is batched and provided to the ministry.

A pilot project under way in the African nation of Ghana seeks to demonstrate the vital role that formalization of landownership can play in helping the poor take a crucial first step away from poverty. Focused on one of the poorest areas in the capital city of Accra, the pilot is leveraging the latest geospatial technologies to create a land titling process and GIS-based land records system where neither existed in the past.

Impetus for the Ghana pilot comes from the Clinton Global Initiative (CGI), started by former U.S. president Bill Clinton to challenge some of the world's leading organizations and individuals to make commitments that positively impact global health, poverty, climate change, and education. Accepting the CGI challenge to work toward alleviating poverty was First American Corp., a major title insurance and real estate information provider based in Santa Ana, California.

With an extensive background in land titling, Craig DeRoy, then president of First American, embraced the economic theories described by Dr. Hernando de Soto in his acclaimed book *The Mystery of Capital.* The Peruvian economist is among the first to identify and describe the relationship between the formal recognition of property rights and the fight against poverty. DeRoy saw the CGI challenge as an opportunity to put de Soto's ideas into action.

With several partners, DeRoy presented the concept of a pilot project to the United Nations Commission on the Legal Empowerment of the Poor, which seeks to "make legal protection and economic opportunity not the privilege of the few but the right of all." The project received immediate feedback and encouragement from the commission's cochairpersons, Madeleine Albright and de Soto.

"Government recognition of landownership [through land titling] gives the poor an identity, which yields numerous benefits," says DeRoy. "The land title can ultimately be used as an asset to leverage permanent change in their economic and financial futures."

According to de Soto, poor people almost everywhere in the world have one thing in common—the only asset they have is the land they occupy. Unfortunately, very few of these people have ever received any type of legal recognition that the land is theirs, especially in situations where the ownership is informal or based on customary forms of tenure. Without a registered deed, title, or lease, the owner cannot leverage the land as collateral to take out a loan that might be used to start a business or improve the property.

From an economic perspective, this untitled land represents trapped capital that could be accessed to stimulate the local financial market with microfinance loans and mortgages. But gaining access to this hidden capital requires the landowners to have formal titles or deeds to their properties.

De Soto's research revealed that the benefits of formal landownership extend beyond the monetary value of loans and mortgages and provide another crucial stepping-stone out of the hopelessness of poverty. A land title gives a person an address, often for the first time, which dramatically improves that individual's sense of identity. As a result, the impoverished enjoy a greater feeling of security that their land won't be taken away and that they can improve the property. People with land titles are more likely to put their children in local schools and demand basic services from the government.

Despite these benefits, land titling and registration are out of reach for most of the poor. The process itself may be too daunting for governments to implement in poverty-stricken areas where no property mapping has ever occurred. And even in countries where titles and deeds do exist, the procedure may be too complicated, expensive, and time-consuming for low-income people to consider. As a result, the capital remains locked in the land, the local economy suffers, and the poor have no way out of their poverty.

Assembling the Team

First American and CGI clearly understood the benefits of land titling and in 2006 agreed on a commitment for the U.S. company to develop a template for cost-effective, in-country creation and maintenance of a land record system that ensures a means for establishing and holding the legal title to a property. To lead this project beyond the original commitment, DeRoy took early retirement and formed a new company called Corporate Initiatives Development Group (CIDG).

"In creating the land record template, the challenge was not in developing it, but in actually implementing it and making it practical," says DeRoy. "There had been much historic debate on the effects of formalizing landownership for the poor, but little had been done to bring these theories to market. I believed it could be done if the right individuals and companies could be engaged, leveraging years of experience and intelligence in land and technology issues to put together a process that could be made simple."

He sought to extend the CGI commitment to include an in-country pilot implementation. To make the pilot a reality, CIDG assembled a team consisting of International Land Systems, Inc. (ILS), Opportunity International, Trimble Navigation, and Esri. Each provides a capability vital to the development of a practical land record system:

- ILS, an Esri Business Partner in Silver Spring, Maryland, is implementing its commercial off-the-shelf GIS-based land recording and registration system, the key deliverable in the pilot.
- Opportunity International of San Diego, California, is a nonprofit microfinance lender already active in Africa.
- Trimble Navigation of Sunnyvale, California, is providing handheld mobile GPS devices that are being used to map the parcels in the field.
- Esri is supplying core technology, in addition to managing the land surveying and mapping activities to create a parcel map, for the land registry database through Sambus Company Ltd., Esri's international distributor in Ghana.

Selection of Opportunity International as a partner in the pilot highlights the important role that microfinance can play in the alleviation of poverty through formalized land titling. Historically, microfinance has focused on lending relatively small amounts of money—$50–$500—to individuals for use in starting in-home businesses. A sewing machine, for instance, can allow a woman to make and sell clothing in her neighborhood. Usually based on short-term paybacks, these loans are often made in trust groups so that peer pressure, not collateral, is the incentive for repayment. The result is a repayment rate of more than 95 percent on microfinance loans worldwide.

"Microfinance brings capital to these emerging markets in a very responsible way," explains DeRoy. "The creation of micro-entrepreneurs is a proven approach to the transformation of entire communities. In our project, we move microfinance one step further by placing Opportunity International, the microfinance lender, into the position of acting as a trusted broker for its clients seeking land registration. This use of the private sector serves to initiate, simplify, and accelerate a process that is often stymied by overwhelming governmental procedures and bureaucracy."

In recent years, microfinance lenders have been looking to expand their reach by loaning larger amounts of money for a variety of uses beyond entrepreneurial business, but this type of lending often requires an asset to be offered as collateral. More often than not, these lenders experience the other side of the situation described by de Soto. They want to loan money to the poor, but the only asset is untitled land, which can't be used to secure the transaction.

This oft-repeated scenario provided Opportunity International an incentive to facilitate land titling as a means of growing the potential market for its microfinance product offerings.

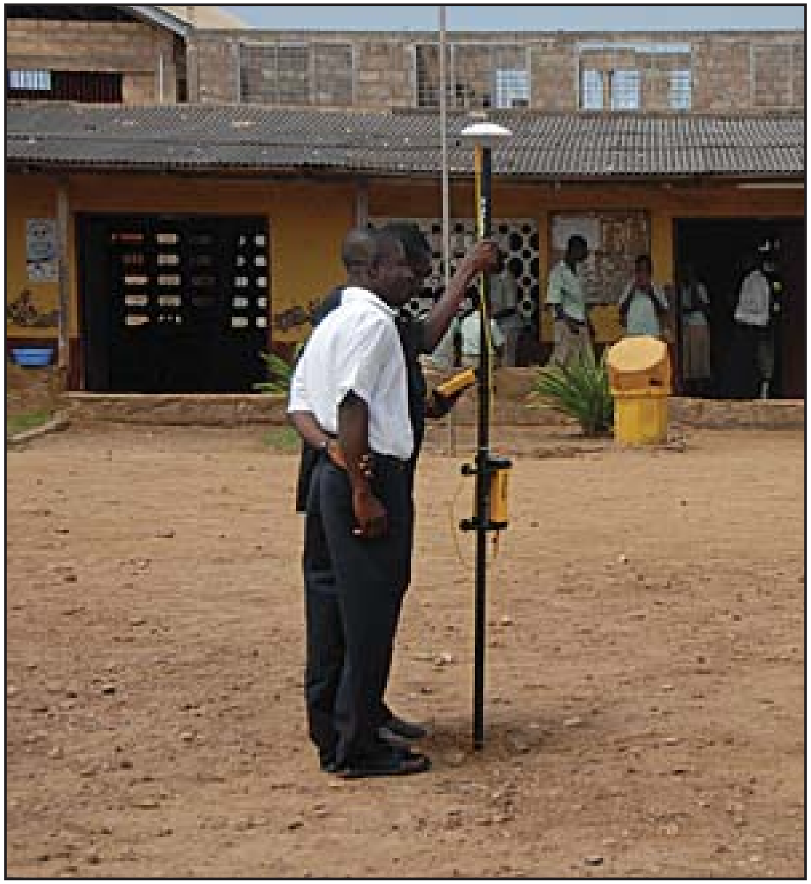
Targeting Ghana's Schools

In 2007, the participants chose a very poor area known as Ashaiman on the outskirts of Accra, Ghana, as the pilot location. Ashaiman is home to about 400,000 people in a 40-square-kilometer region where most of the structures can best be described as shacks and shanties. It was considered ideal for the pilot because Opportunity International is actively involved in microfinance there and had already been considering developing loan programs for the hundreds of private schools located in the area.

Operation of private schools is a growing business in Ghana, and the owners are seeking funds to build additional facilities and accommodate more students. From a mapping perspective, the schools were appealing for the pilot because the boundaries of their land are usually well defined. The decision was made to target only private schools in the initial pilot, because they presented the best opportunity to demonstrate the mutually beneficial link that can be made between formalized land registration, microfinance, and poverty alleviation.

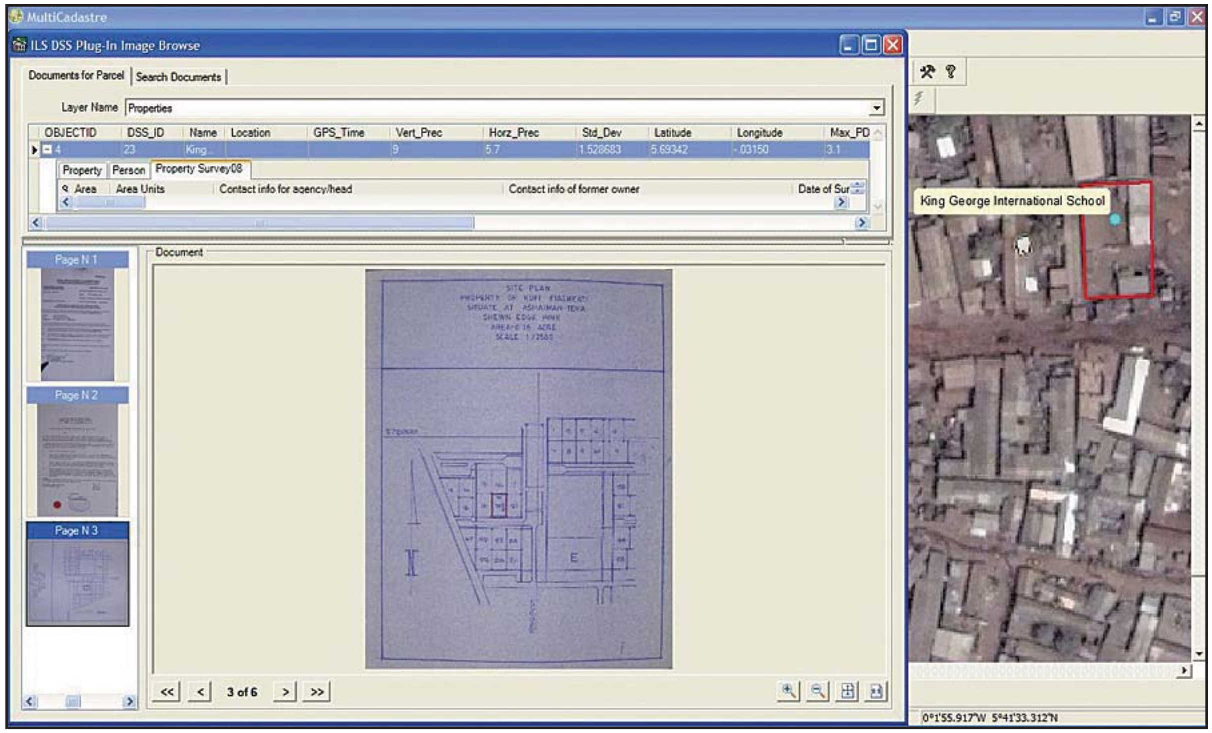
Although the Ashaiman pilot is being conducted in close cooperation with the Ghana Ministry of Lands, Forestry and Mines, the project is relying solely on private funds. In this case, the fees associated with land titling will be rolled into the cost of processing the loan, so there will be no up-front transaction expense for the school operator to register a title. Economies of scale in processing multiple titles are expected to reduce costs significantly as the land registry becomes operational.

Implementation of the pilot began in March 2008, and land titling had been completed for more than half of the 51 private schools in the pilot zone by August. This adjudication process involves surveying the school property with GPS-based mobile GIS equipment, creating a legal description of the land, and collecting property ownership information from the school operators and neighbors via personal interviews conducted by members of the local team. Each school owner has sought to become part of the land registration pilot and actively participated in the required procedures as part of the loan processing.



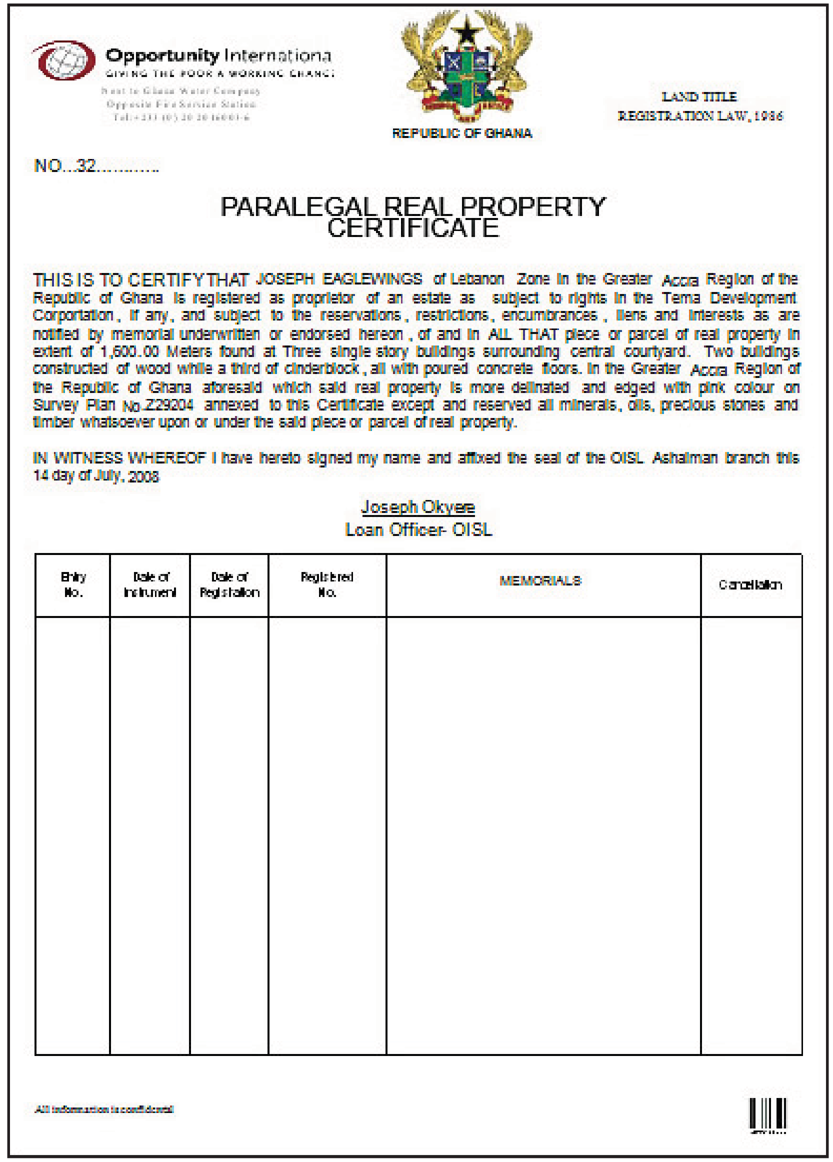
Ghanaian surveyors perform a cadastral survey of the property boundaries as described by the occupant, as well as neighbors.

As the interviews and fieldwork are completed, ILS is uploading the data into its parcel-based MultiCadastre package, an off-the-shelf product that incorporates ArcGIS functionality to link the title information with the digital parcel map. This system is already managing the entire title registration process and workflow in a fully automated environment. For the pilot phase, this system will be maintained at the Sambus office and will generate paralegal land titles that will be provided to the participating schools for use in securing private loans.



Using ILS MultiCadastre, all surveyed schools can be viewed. The ILS document scanning system plug-in allows for documents and images associated with each property to be examined as well.

The term *paralegal title* is used to indicate that the titling process has been initiated for acceptance by the private sector to jump-start microfinance activities. This commitment from the private sector is designed to give the government of Ghana the confidence to use the paralegal titles as the starting points for official title processing in the public land registry.



Opportunity Internationa
GIVING THE POOR A WORKING CHANCE
Next to Ghana Water Company
Opposite Fire Service Station

REPUBLIC OF GHANA

LAND TITLE
REGISTRATION LAW, 1986

NO...32...........

PARALEGAL REAL PROPERTY CERTIFICATE

THIS IS TO CERTIFY THAT JOSEPH EAGLEWINGS of Lebanon Zone in the Greater Accra Region of the Republic of Ghana is registered as proprietor of an estate as subject to rights in the Tema Development Corportation, if any, and subject to the reservations, restrictions, encumbrances, liens and interests as are notified by memorial underwritten or endorsed hereon, of and in ALL THAT piece or parcel of real property in extent of 1,600.00 Meters found at Three single story buildings surrounding central courtyard. Two buildings constructed of wood while a third of cinderblock, all with poured concrete floors. In the Greater Accra Region of the Republic of Ghana aforesaid which said real property is more delinated and edged with pink colour on Survey Plan No.Z29204 annexed to this Certificate except and reserved all minerals, oils, precious stones and timber whatsoever upon or under the said piece or parcel of real property.

IN WITNESS WHEREOF I have hereto signed my name and affixed the seal of the OISL Ashaiman branch this 14 day of July, 2008

Joseph Okyere
Loan Officer- OISL

Entry No.	Date of Instrument	Date of Registration	Registered No.	MEMORIALS	Cancellation

All information is confidential

The ILS DSS system allows for the creation of a paralegal title based on information gathered during the interview process.

While the overall aim of the Ghanaian project is to continue to rely on private-sector entities to perform the land surveying and title recording work in support of microfinance work, participants are simultaneously assisting the government in modernizing its land titling and cadastral capabilities with many of the same GIS-based systems being implemented in the pilot. All title and parcel data collected for loan processing is batched and provided to the Ministry of Lands for its own land registry, which the team believes will be among the world's most technologically advanced.

According to DeRoy, this project demonstrates the true effect of what is called the "leapfrog factor." Given the rapid pace of technology development, those who come to implement a system of land registration today and are not burdened with existing infrastructure or bureaucracy can gain the maximum benefit from streamlined and cost-effective new processes while leveraging proven solutions.

"It is terrific that microfinance has matured to the point of being accepted as a traditional banking solution for the emerging markets of the world," says DeRoy.

About the Author

Peter Rabley is president of International Land Systems, Inc., with more than 20 years of experience designing and implementing land information systems around the world.

More Information

Further reading: "The Power of One," *Time* magazine, July 16, 2007, by Madeleine Albright and Hernando de Soto.

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

Early Warning Planning for Mosquito-Borne Epidemics

GIS, High-Resolution Remote Sensing Help Evaluate Degrees of Risk in Senegal

By Yves M. Tourre, Delphine Fontannaz, Cécile Vignolles, Jacques-André Ndione, Jean-Pierre Lacaux, and Murielle Lafaye

Highlights

- GIS tools and remote sensing were used to detect potential breeding ponds.
- In situ observations validated the indexes.
- Using ArcView, researchers calculated mosquito density and evaluated cross-potential risks.

Fifty years of successful efforts in the prevention and control of infectious diseases and epidemics have inspired confidence and optimism in modern medicine and technology. Nevertheless, epidemics remain a conspicuous challenge to public health today. In the context of climate change and rapidly increasing population, some epidemics are even reemerging.

For example, the Ferlo region in Senegal, Africa, became prone to Rift Valley fever (RVF) in the late 1980s when virus-carrying mosquitoes *Aedes vexans* and *Culex poicilipes* appeared. The latter species proliferate near temporary ponds and neighboring humid vegetation. RVF epizootic outbreaks in livestock cause spontaneous abortions and perinatal mortality. So far, human-related disease symptoms are often limited to flu-like syndromes but can include more severe forms of encephalitis and hemorrhagic fevers. As a result, local socioeconomic resources can be seriously affected.

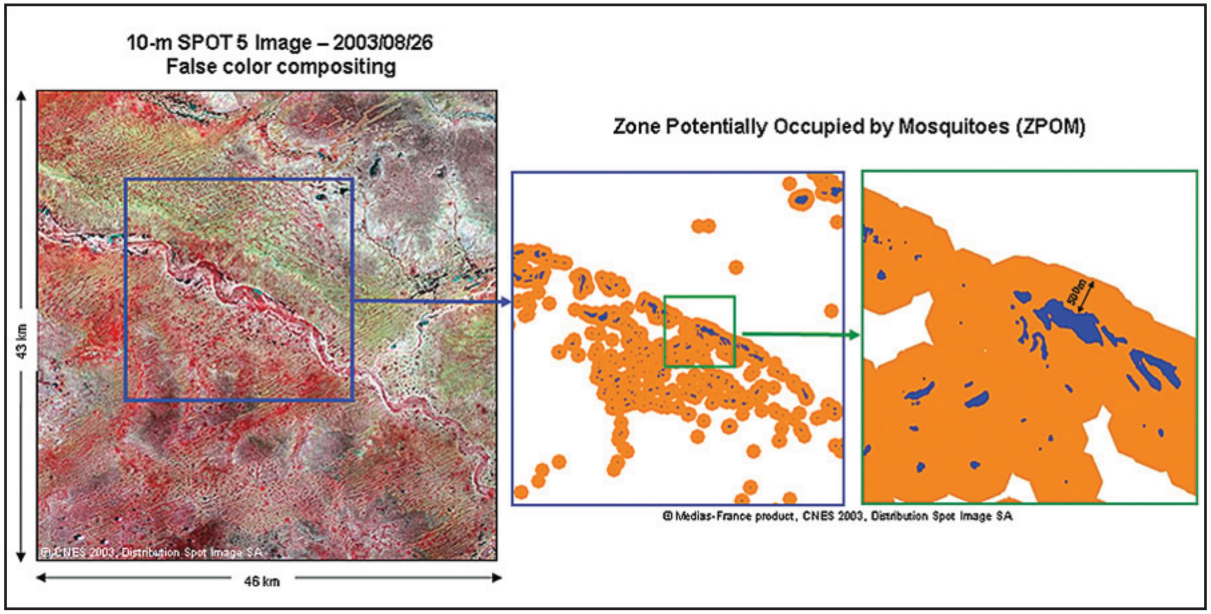
Professor P. Sabatier at the University of Grenoble indicated that this growing threat created an urgent need for a local early warning system (EWS) for RVF epidemics in Senegal. The goal was to use specific GIS tools and remote-sensing images/data to detect potential breeding ponds and evaluate RVF diffusion and areas with potential risks.

Project Description and Preliminary Methods

MEDIAS-France implemented the RVF project in the Ferlo region under the auspices of the French Spatial Agency (Centre National d'Etudes Spatiales). MEDIAS-France is a nonprofit corporation that coordinates research groups studying global environmental issues in areas including the Mediterranean Basin and subtropical Africa.

In the Ferlo region, the abundance of mosquitoes is linked to rainfall, ponds and their turbidity, and the presence or absence of vegetation in ponds (e.g., water lilies, wild rice). Initially, Environment for Visualizing Images (ENVI) 4.3 imagery processing software from ITT Visual Information Solutions was used for spectral analysis of high-resolution (~10 m) SPOT 5 images to locate the ponds. First, image registration tools were used to warp the images to match and implement relative georeferencing for all SPOT 5 images collected, with further adjustment to minimize spatial errors. Then, new indexes were obtained by using the classic Normalized Difference Vegetation Index (NDVI) transform tool to allow the combination of different spectral bands (such as the middle infrared [MIR] and the near infrared [NIR] red and green bands). The Normalized Difference Pond Index (NDPI) allowed detection of all ponds; the Normalized Difference Turbidity Index (NDTI) allowed the evaluation of water transparency or turbidity. In situ observations by participants from the Center for Ecological Monitoring (Centre de Suivi Ecologique) in nearby Dakar validated the indexes using GPS and GIS.

Using these methods, small ponds were located with precision, making it further possible to map RVF risks from zones potentially occupied by mosquitoes (ZPOM) following recent studies from entomologists on flying ranges and spatial distribution of mosquitoes.

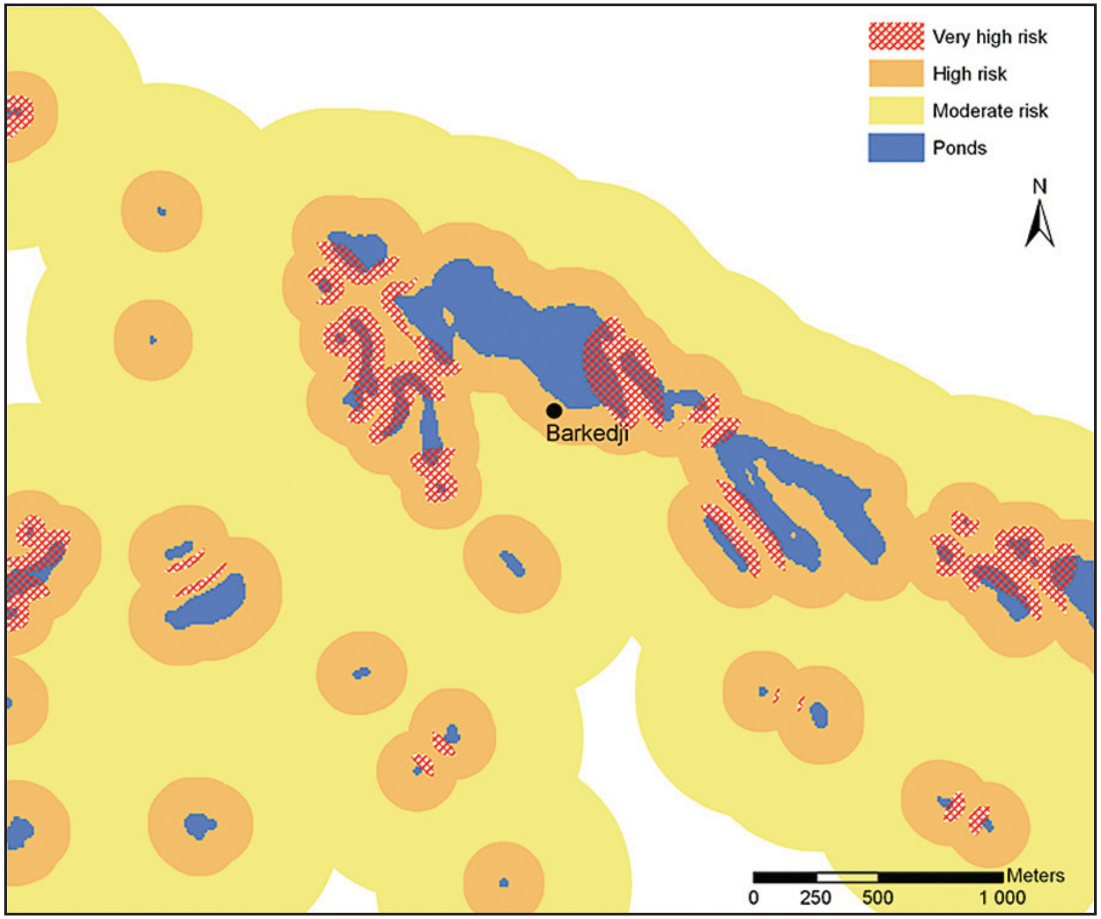


A false-color composite of a 10 m SPOT 5 image (left) and ENVI 4.3 software were used to obtain a new pond index (NDPI). From the NDPI, ponds (in blue) were precisely located (center and right). The 500 m zone potentially occupied by mosquitoes (ZPOM) is shown in orange.

GIS Methods

Further refinement and simplification were needed, however, because of the complexity of the pond distribution and to develop an effective usage strategy for local health information services. Researchers wanted to identify degrees of risk from isolated and/or clustered ponds, calculate the target risk coverage area, and evaluate risk by mosquito density in overlapping zones.

Because of researcher Delphine Fontannaz's GIS expertise and the availability of new detailed information in the zones, the GIS approach became an obvious solution for the team. Using ArcView software and tools (e.g., conversion and data management for spatial projection and transformation, as well as overlay and proximity vector data analyses), maps obtained from SPOT 5 10-meter multispectral resolution imagery were first transformed into appropriate formats, then converted from raster to vector formats. The georeferencing accomplished through universal transverse Mercator (UTM) WGS 1984 for zone 28N permitted further comparison and processing.



ArcView conversion, data management, and analysis tools enable the display of an improved three-zone ZPOM for potential Rift Valley fever risks. The very high-risk zones are red-hatched to identify underlying pond limits.

The initial ZPOM was first divided into three bands chosen for defining risk levels for potential virus transmission by *Aedes vexans.* Then, using ArcView software, researchers calculated mosquito density and evaluated cross-potential risks. They noted that zones with very high and high risks were inhabited by potential reservoirs, i.e., carriers (snakes, frogs, and toads), of the RVF virus and produced an improved ZPOM.

Results

The analyses using GIS technology allowed researchers to see that risks increase when ponds are close to each other. Using GIS technology, researchers created a new, more detailed, and more useful ZPOM. GIS tools provided new products and information for use by local early warning systems in the prevention of disease.

Future Applications

This technique might be improved by adding digitized ecological zone layers. Multidisciplinary users can benefit from this data by using it to choose strategic positioning of villages and parks according to RVF risks. This new methodology is also being transferred to other teams in Africa for varied types of mosquito vector research.

About the Authors

Tourre, Fontannaz, Vignolles, and Lacaux are affiliated with MEDIAS-France, Toulouse, France; Ndione is affiliated with the Centre de Suivi Ecologique (CSE), Laboratoire de Physique de l'Atmosphère et de l'Océan, Université Simon Fongang, Dakar, Senegal; and Lafaye is affiliated with the Centre National d'Etudes Spatiales (CNES), Toulouse, France.

More Information

For more information, visit the Web site at www.redgems.org. This article has been adapted from the Esri e-newsletter *ArcWatch*, November 2007, www.esri.com/arcwatch, which includes original references.

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

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