Enterprise GIS for Emergency Respon`se:
A CASE STUDY OF THE BROWARD COUNTY SHERIFF'S OFFICE

Paper Abstract
In 2002, under the leadership of Sheriff Ken Jenne, BSO was "re-introduced" to GIS technology by establishing an Enterprise GIS that integrated mapping technology into the agency's law enforcement business processes. To further that challenge, in September 2003, the Broward County Fire Rescue was merged under the Broward Sheriff's Office (BSO). This merger marks the first time in United States history that a fire rescue department and a sheriff's office have merged. The arrangement establishes the Broward Sheriff's Office as a "full service" public service agency. This presentation will unveil the strategies and applications being developed to meet the ever-increasing public safety demands from both law enforcement and fire-rescue--ranging from Mobile GIS for Critical Response/Homeland Security/E911 Dispatch/Disaster Response, Web-based mapping applications for Felony Warrant tracking, customized querying tools for Fire-Rescue and Crime Analyses, 3-D visualization of Public Safety Facilities, Plume Modeling for Disaster-Response, and much more.

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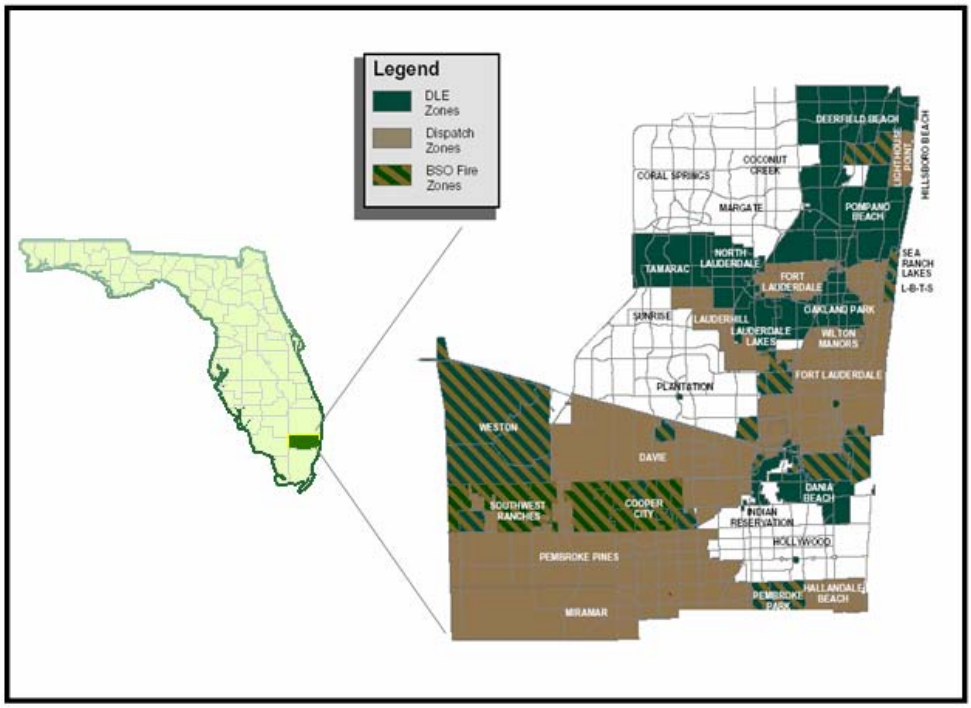
Introduction

One of government's most important jobs is to protect its citizens from crime, terrorism, and natural disasters. Furthermore, it is expected to do so in an increasingly effective manner, to reduce costs, and to improve intergovernmental cooperation though professional collaborations, joint data sharing, and obtaining economies of scale by combining efforts. This paper describes the emergence of the Broward County, USA Sheriff's Office (BSO) as a "full service" public safety agency, their experience with geo-informational technology, and its current and planned GIS operational agenda.



Broward County, Florida, USA is located on the southeast coast of Florida. It lies at the center of the Miami-Fort Lauderdale-West Palm Beach metroplex, an area encompassing some 4.5 million permanent residents (which often swells to over 7.0 million people seasonally). The county is bordered on the east by the Atlantic Ocean and elsewhere by Palm Beach, Hendry, Collier, and Miami-Dade Counties. There are approximately 1.7 million permanent residents located on 409.8 square miles of developable land (the remainder of the total 1,205 square miles is primarily the Everglades Preserve). There are 28 municipalities in the County.

BSO is responsible for providing public safety to all of Broward's unincorporated areas as well as contracted services to 14 municipalities, the Ft. Lauderdale/Hollywood International Airport, Port Everglades (the 12th busiest container port in the U.S.), and the Broward County Mass Transit system. Moreover, in 2003, fire rescue, emergency services, and E911 communications responsibilities were added to the Sheriff's office as the result of a merger. Finally, the Broward County Sheriff is the co-chair to the Florida Regional (Broward, Miami-Dade, and Monroe counties) Domestic Security Task Force.

The GIS Unit was established in 2002 with the end goal of providing efficient and effective integration of disparate crime and other disaster and emergency management databases and operational models. These include: providing Emergency 911 dispatch, law enforcement, detention, probation, fire rescue, emergency medical services and Homeland Security. The range of uses creates a disparate set of requirements leading to concerns over the timeliness and integrity of the data. Additionally, the variety of potential end-users ranges from GIS specialists to disaster-relief volunteers with no technical background. Since that time, the GIS Unit has explored new uses for GIS technology that supports public safety responses to both man-made and natural disasters.

This paper is structured as follows. First, the U.S. GIS and public safety context is briefly described. Second, the GIS software tools currently employed by BSO are reviewed in terms of both capability and experiences. Third, existing practices and evolving technologies within the BSO GIS Unit are described. Lessons learned and recommendations for further implementation of the Enterprise GIS within the GIS Unit of BSO conclude this paper.

Literature Review

The majority of the GIS and public safety literature often takes the form of speculative inquiry into the *potential* use and advantages of GIS. The following section outlines these statements in an effort to provide a framework for discussion of BSO's GIS Unit which follows.

The Department of Homeland Security's Information Analysis and Infrastructure Protection's budget request acknowledges the importance of the use of GIS in emergency response. This budget line is stated for purposes of "mapping threat information against our current vulnerabilities, and the development and maintenance of a complete and accurate mapping of the Nation's critical infrastructure and key assets."

The Federal Geographic Data Committee (FGDC) is an interagency committee composed of representatives from the Executive Office of the President, Cabinet-level and independent agencies. Currently, the FGDC is developing the National Spatial Data Infrastructure (NSDI) in cooperation with organizations from State, local and tribal governments, the academic community, and the private sector. The NSDI encompasses policies, standards, and procedures for organizations to cooperatively produce and share geographic data.

In one of FGDC's publications, an emphasis is placed on the "importance of the implementation of a comprehensive national spatial data infrastructure, interoperability of the systems that process this information, and commonality of the processes that collect, manage and disseminate geospatial information." However, there are methodological concerns that need to be addressed to achieve assurance of data and technology accessibility and interoperability. These include: having national data standards to set a framework for providing data that is immediately useful for Homeland Security; consistent and standardized road data for Emergency 911 (E911) capabilities; and having current and accurate data on the Nation's critical infrastructure accessible to relevant agencies.

Cutter, Richardson and Wilbanks (2003) argues that one of the top areas of concentra-

tion for the national policy officials and geographic researchers on Homeland Security is the geospatial data and technologies infrastructure. Priority action items to promote this endeavor include establishing "a distributed national geospatial infrastructure as a foundation for homeland security" to simultaneously serve multiple needs, including "local government, planning, environmental protection, and economic development."

The World Trade Center attacks demonstrated the importance of having GIS as a foundation in emergency response. Langhelm (2002), the GIS Coordinator for the Federal Emergency Management Agency (FEMA), addressed the supporting role GIS had as "invaluable in the response and recovery efforts in disasters in recent years." Much of the initial work focused on search and rescue with an operation staffed by 25 people working 24-hour operations over two GIS nodes. After the initial support, Langhelm continues, "GIS products supported decision-making" and this allowed officials to "see the site in a completely different perspective."

A variety of difficulties arose during the post-9/11 recovery effort that, perhaps still, adequately describes the problem context for the use of GIS in public safety applications. These included: the availability of office space, power, web connectivity, data access and inadequate staffing; data, particularly building addressing issues, since there were many occurrences of multiple street addresses; and data unavailability about subsurface infrastructure.

Enterprise GIS Infrastructure

The goal of creating an Enterprise ESRI GIS solution was the agency's need for a single, integrated information platform for all of its geographic information, which would make it easy to deploy user-friendly applications via the desktop or web-based while allowing the ability to share geographic information among other government agencies, particularly public safety entities. BSO has adopted ESRI product line as the standard platform for the agency-wide geo-spatial infrastructure. (Refer to Decision Factors for Using ESRI as Standard Platform)

The GIS Unit is responsible for the design, implementation, management, and maintenance of the agency-wide geospatial data warehouse.

ArcSDE™ which is middleware for ESRI GIS clients that serves as a gateway to GIS data stored in a SQL-based Relational Database Management System (RDBMS). The ArcSDE™ Spatial Warehouse provides the agency to turn data into a strategic geospatial resource, including advanced object-oriented database technology, .Net platform. The ArcSDE Geospatial Data Warehouse enables access to all information on any scale, in any, where ever it exists.

Decision Factors for Using Adopting ESRI Platform

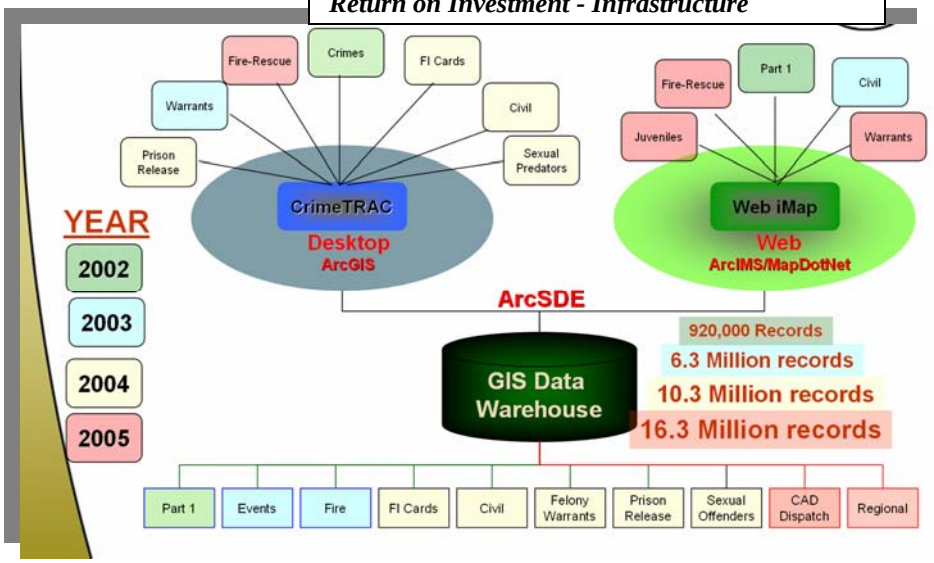
- ✓ An 'Open GIS Database Environment' allowing the integration of disparate database into a single geo-spatial database. It was essential to avoid 'proprietary-based' mapping system that make it difficult to bring in/out GIS layers into the system.
- ✓ Utilizing a centralized, geo-spatial database to deploy both desktop GIS and Web-based GIS applications
- ✓ Centralized, standard, and integrated information platform for all of our geographic information, which would make it easy to share geospatial data among all local government agencies in the South Florida region
- ✓ Ability to access Broward County's ArcSDE™/Oracle Enterprise System – direct access through ArcSDE™ to County-wide GIS layers which are utilized by BSO – aerials, streets, cities, child care services, shelters, public schools, etc.
- ✓ Ability to access use Regional/County GIS Layers since a vast majority of regional/county/state government agencies utilize ESRI as their standard GIS platform
- ✓ Ability to develop application from 'out-of-the-box' in order to meet the mapping needs of the agency, ensuring a robust yet user-friendly application. ESRI products utilize C API, allowing application to be built via .COM, C++, C Sharp, Visual Basic, and .NET platforms
- ✓ All data is spatially geo-referenced to a standard map projection / coordinate system / datum. 'On-the-fly' coordinate system and projection conversion within the ESRI product
- ✓ Conversion tools / Universal Translators to integrate data from various GIS platforms (Integraph, MapInfo, AutoDesk, etc.)

Prior to GIS, the agency was not able to integrate its databases which are maintained by different departments within the agency. Since BSO lacked a true Records Management System, geocoding processes were created to spatially-enable incident-related information while simulatanously being linked to other tables associated with an incident. The biggest advantages of developing an Enterprise GIS using ArcSDE™, is that it also promotes *operational effectiveness* since the disparate databases can be integrated geographic information can be accessed through either Desktop GIS application development or web-based GIS.

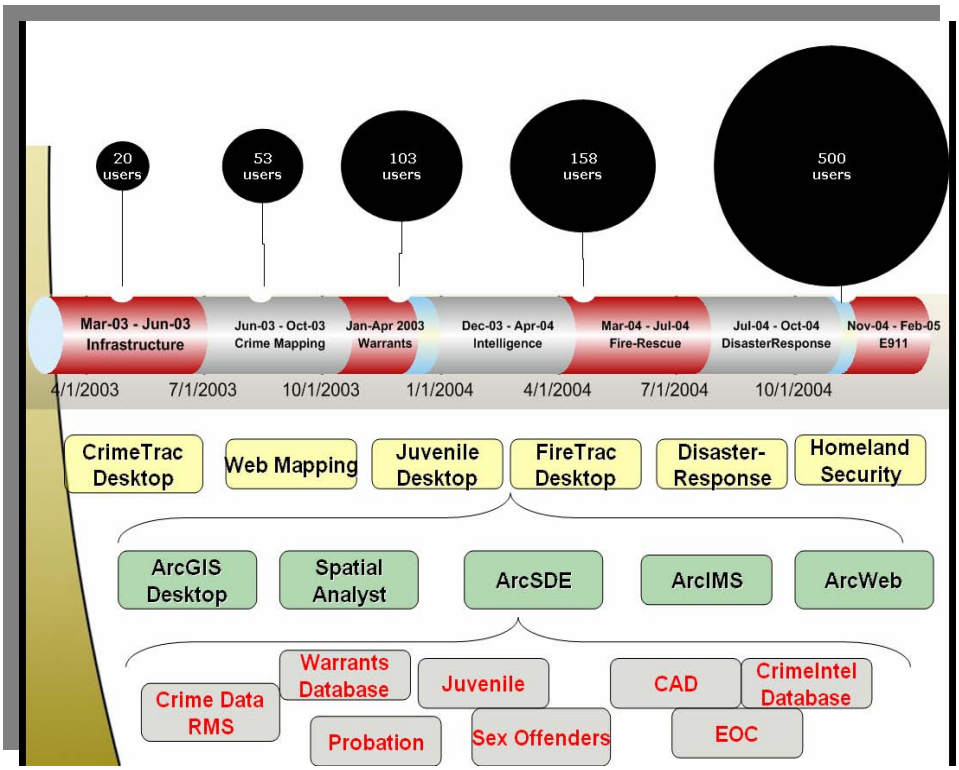
In fact, ArcSDE™ provides the foundation for the agency's desktop and web-based mapping applications. As shown in the ***Return on Investment - Infrastructure*** figure, all the various disparate databases go through geocoding services which are updated and stored in the ArcSDE.

Within a short-time frame, utilizing ArcGIS Desktop, ArcEditor, Spatial Analyst, ArcSDE, ArcIMS, and ArcWeb Services, the user based expanded vastly, within a **19**-month time frame, BSO personnel utilizing the ESRI-based Enterprise solution rose from 20 users to 500 users within a 19 month time frame (March 2003 to November 2004). This was largely due to the ESRI's thin-client solutions such as ArcIMS and ArcWeb Services, as well as ESRI business partners such as IS Consulting (MapDotNet), Bradshaw Consulting (Crime iMap) and North Star Geomatics.

Return on Investment - Infrastructure



Return on Investment – TimeFrame to Implement from 20 GIS Users to 500 GIS Users



Benefits associated with the GIS Data Infrastructure are:

- ✓ Improving the ability to *integrate* disparate databases providing greater access to more detailed information relating to public safety-related incidents.
- ✓ Increasing *availability* to all BSO personnel regarding the most current information relating to mapping incidents via ArcView GIS and Web-based mapping (Crime iMap and iMap Data).
- ✓ Improving *decision-making* by displaying incidents visually and access to large amount of information as it relates to the incident
- ✓ Improving data sharing since the GIS database can integrate data from a variety of sources, including data from outside agencies
- ✓ Eliminating *redundancies* in terms of geocoding by each district and departments
- ✓ Improving *Data Quality/Accuracy* since GIS allows BSO to visually identify data entry errors within the data such as incorrect addresses, zone name, etc.
- ✓ Improving *confidence in analysis* since the data quality control is being monitored visually

Technology - Software

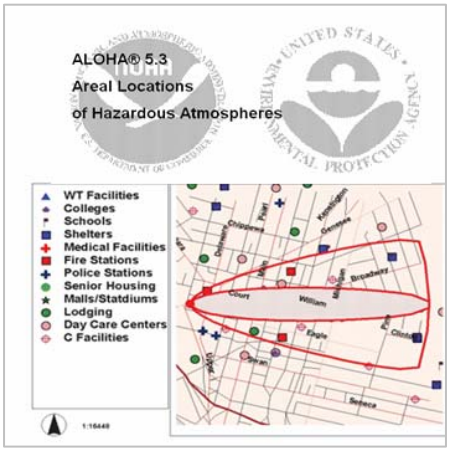
This section examines the technologies that BSO has implemented to analyze and respond to emergency situations. The programs are able to examine both man-made and natural events. Each software program has capabilities to both gauge the effects of an event as they occur as well as the ability to create scenario event analysis.

ALOHA

The U.S. Environmental Protection Agency (EPA) and National Oceanic and Atmospheric Administration (NOAA) use a plume-dispersion model called Aerial Locations of Hazardous Atmospheres (ALOHA) (e.g., EPA, 2002). ALOHA's database includes a chemical library about the physical properties of approximately 1,000 common hazardous chemicals. The air-modeling program is used to predict the spread of chemical vapors, creating a footprint that can be overlaid on other pertinent GIS layers, allowing users to track the chemical's gas cloud or "plume" in order to determine its potential impact on nearby population centers.

ALOHA program is designed to be easy to use. Inputs required are: city, time, and date of the liquid spill; the selection of the chemical from the program library; current weather conditions, including the direction and speed of wind and other variables that would affect the dispersion of the plume; and a description of how the chemical is escaping from containment.

The results may be displayed graphically using an ESRI-based extension, called ALOHA Conversion Analysis and Summary (ACAS), designed to integrate the plume-modeling results directly into ArcGIS. This allows the user to analyze the plume model data automatically within ArcMap to diagram potential scenarios. Data output may also include graphs showing predicted chemical concentrations at any location of concern downwind of a release and the dose of chemical to which people at that location may be exposed to.



ALOHA / BSO

ALOHA initially was offered to BSO in 1992. The impetus was the need for a tool in the event of a chemical leak at Port Everglades as well as its close proximity to the Fort Lauderdale International Airport. The program was a stand-alone application that allowed prediction of the footprint - shown on a scaled grid – of a gas cloud after an accidental chemical release. It was intended to be easy to use by those unfamiliar with chemicals, emergency responses, or GIS.

The software was utilized to create several scenario events. During the scenario events, several limitations were identified. Despite improvements to ALOHA between 1995-2003 such as improvements in dispersion and source, (1995 - ALOHA 5.2.1), updated information on chemicals (2002 - ALOHA 5.2.3), and inclusion of flammable explosives (2003 - ALOHA 5.3), the product had limited use. Although BSO could generate footprints depicting a chemical dispersion, it does not include any direct connection to GIS. The footprint must be exported from ALOHA into ArcView 3.x utilizing an ALOHA extension in this GIS product.

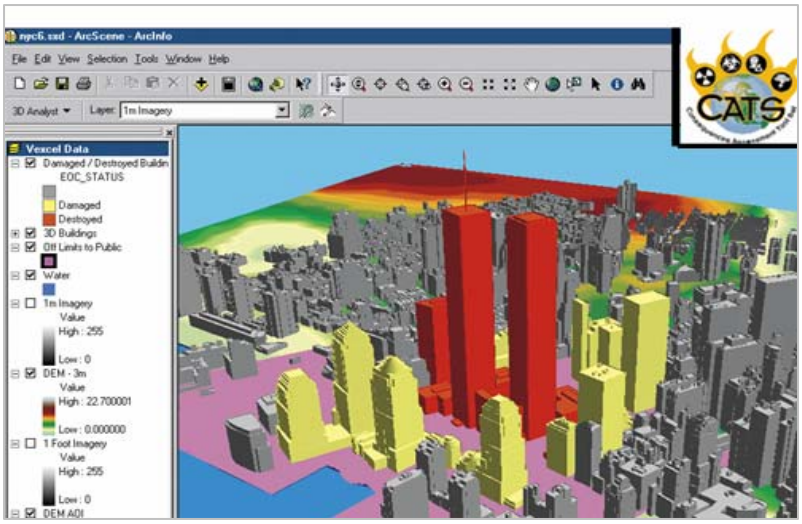
Since the intention was to provide BSO personnel with a user-friendly tool to measure chemical dispersions with GIS capabilities, the program proved to be difficult since BSO personnel lacked GIS training and at that time there was no GIS Unit established at BSO. Another limitation with ALOHA was its ability to assess and predict 'man-made' explosions. Based upon the lack of interoperability between GIS and the inability to assess and predict the consequences of a 'man-made' explosion, BSO has turned to utilizing the CATS/JACE program.

CATS / JACE

Developed under the guidance of FEMA and The Defense Threat Reduction Agency (DTRA), the Consequences Assessment Tool Set (CATS)/Joint Assessment of Catastrophic Events (JACE) software provides powerful disaster analysis in real time with a rich set of information integrated from a variety of sources (e.g., DTRA, 2004). The software is deployable for actual emergencies with capabilities including contingency and logistical planning as well as consequences management.

The CATS program integrates hazard prediction, consequence assessment and emergency management tools with critical population and infrastructure data. It uses tools and data to both: (1) predict the hazard areas caused by natural phenomenon, inadvertent human actions and intentional hostile events, including chemical, biological, radiological, nuclear and explosive incidents, earthquakes, and hurricanes; and (2) help estimate collateral damage to facilities, resources, and infrastructure and creates mitigation strategies for responders.

The CATS system provides for a multitude of events. Information is included within the software for nuclear, biological and chemical hazards as well as for hurricanes, storm surges, and earthquake events. The software provides a user-friendly graphic interface and predefined event scenarios. A variety of skill levels are anticipated. The GIS interface enables the user to combine and manipulate



multiple layers of information to assess affected persons, property and infrastructure.

CATS/JACE Implementation by the BSO

BSO acquired CATS/JACE software in 2002. The impetus was the preparation for natural or man-made disasters. The GIS Unit has aggressively tested this software utilizing ArcView 3.x as the operating systems. CATS/JACE has enabled BSO personnel to combine multiple layers of information such as aerial photography, census block demographics, location of first responders (i.e., fire stations), hazards, and casualty probabilities to determine total number of persons affected. Of particular interest is the spatial component, which helps to answer the geographic-related questions: (1) what geographic areas will be impacted based upon time, place, chemical/explosion, weather and release, (2) what populations will be impacted and may need to be notified, (3) what adult living facilities and/or schools may need to be evacuated, and, (4) what hazardous sites are nearby.

The implementation of CATS/JACE has provided the BSO with the program it needs to effectively manage emergency situations. The software allows for the organization of resources in response to a broad range of events. As the software is fully integrated into the department, its effectiveness will be fully realized.

Despite the usefulness of the CATS/JACE program, it is not able to closely analyze losses from natural hazards. The common occurrence of major weather events in South Florida has generated the need for additional software that would allow for an intensive analysis of these events. The HAZUS program was chosen for this task.

HAZUS-MH

In the early 1990's, FEMA sponsored a study by the National Institute of Building Sciences (NIBS) for the express purpose of considering how earthquakes might affect the nation and what methods of mitigation might be useful. These studies resulted in the development of the Hazards U.S. software (HAZUS). The early versions of HAZUS were intended to provide accurate loss estimations in the event of seismic activity.

The program has evolved into Multi-Hazards HAZUS (HAZUS-MH) (e.g., FEMA, 2004). This software acts as a loss estimation and risk assessment program covering earthquakes, hurricane winds, and flooding. By modeling the physical world of buildings and structures and then subjecting it to the complex consequences of a hazard event, users can implement this tool to prepare for a natural disaster, respond to the threat, and analyze the potential loss of life, injuries, and property damage.

In the HAZUS-MH program three levels of intensity or detail can be employed, with each level based upon the quality and detail of the initial data input. A user choosing the level of implementation would likely base the decision on the funds available for data gathering and input, as well as the level of detail required in the output.

FEMA'S MULTI-HAZUS LEVEL OF ANALYSES

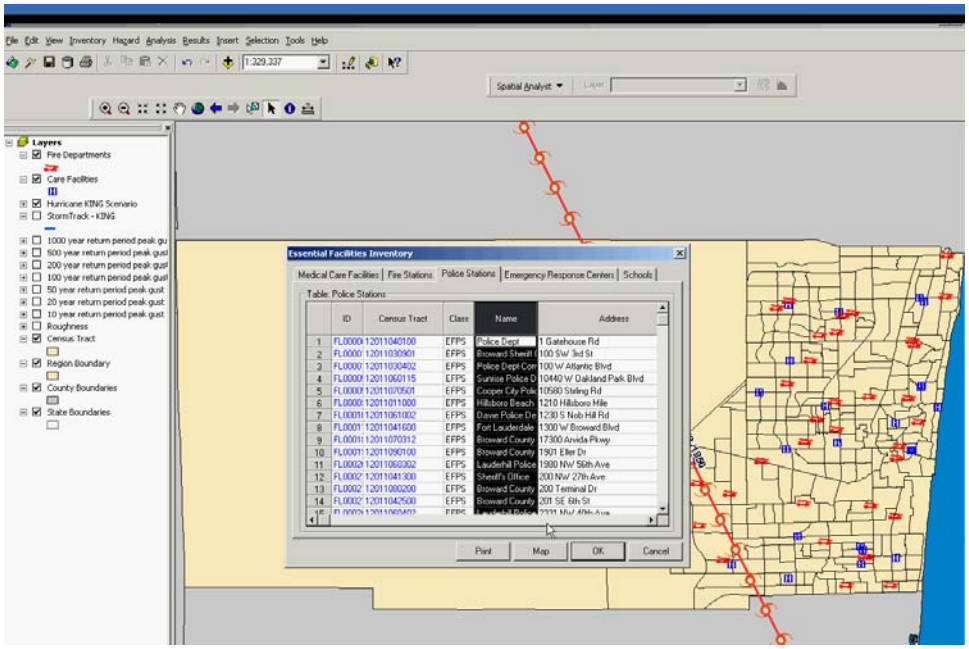
Level 1 Analysis: HAZUS software was created with a default database of information for each region of the U.S. These data are highly generalized and their accuracy is only provisional. The data within the level 1 database include the number of buildings in the area and their value, basic population characteristics, costs of building repair, and basic economic data.

Level 2 Analysis: This analysis is the standard level of implementation of the HAZUS software. While the input requirements expected from the user are greater, a far more extensive and accurate set of analyses and outputs can be provided. Costs can still be limited by the amount of information that is collected, but – as before – the greater the input, the greater the output. Local data inputs would include details of local building conditions and construction, local soil conditions, flood areas and local economic data.

Level 3 Analysis: This level showcases the flexibility of the HAZUS program by permitting customization. For example, customized analysis may be applied to examine threats to high-potential loss facilities such as dams, nuclear power plants or military installations. Specialized data structures and methodologies can be deployed

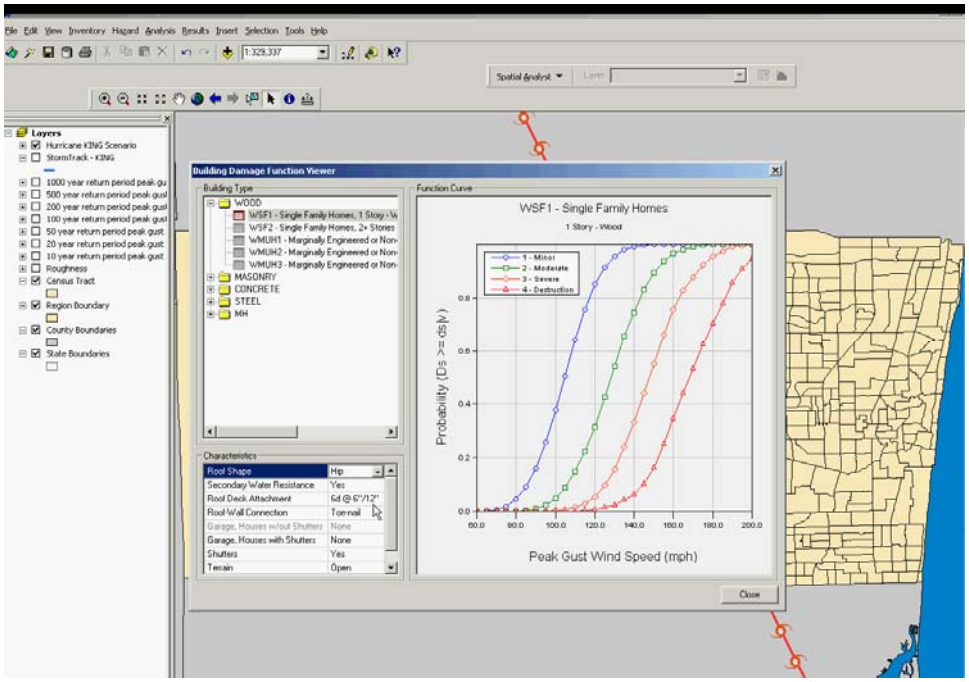
Role of HAZUS-MH at BSO

HAZUS-MH served a practical use for BSO during Hurricane Jeanne, which struck South Florida on September 26, 2004. Utilizing wind swaths generated from FEMA's HURREVAC 2000 software program, BSO overlaid the wind swaths within HAZUS to determine what essential facilities (fire-rescue stations, police stations, and shelters) may be impacted. BSO updated the essential facilities information as it relates to public safety facilities to better assess damage to these facilities as well as to determine how many people would be utilizing designated shelters.



Using Multi-HAZUS in estimating number of essential facilities impacted in this Hurricane Scenario

However, the use of HAZUS was limited since the data in the program has not been significantly updated with the local data. Importing information on building stock, essential facilities, land use, and economic data would greatly improve the usefulness of the output. If South Florida emergency responders are to maximize the use of HAZUS, it will require extensive coordination and cooperation among other entities. Working with Broward, Miami-Dade, and Palm Beach counties as well as the South Florida Water Management District (SFWMD), BSO is looking to develop a South Florida Regional HAZUS Work Group to provide the data needed to customize HAZUS for Level 2 and Level 3 Analyses.



Using Multi-HAZUS in analyzing damage to building structures.

Evolving Enterprise GIS

This section examines three evolving projects within BSO's GIS Unit. These are: the supply of GIS data to officers in the field for critical incident response situations; planning for Homeland Security initiatives; and implementing the Wireless Technology - Federal Communication Commission (FCC) Phase II.

Use of GIS technology for Critical Incident Response

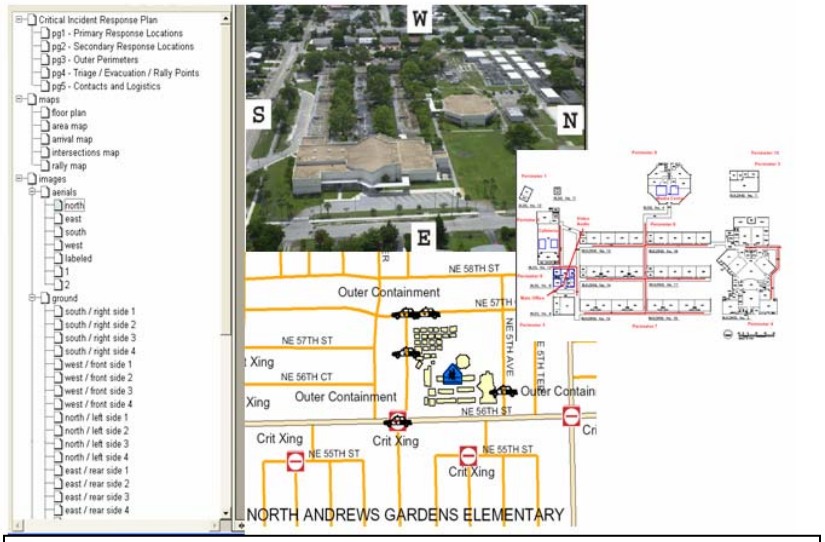
In 2000, the Sheriff challenged his agency to develop a portable visualization tool to combat school violence, crimes and other emergencies. BSO subsequently equipped 1,600 road patrol deputies, supervisors, dispatchers, SWAT teams, and school resource deputies with a portable compact disc (CD) that contained, among other things, street/parcel maps, detailed floor plans, aerial photos, and interior pictures of 125 public and private elementary, middle, and high schools in the agency's jurisdiction.

GIS was used to map all strategic locations around schools, utilizing the best and most currently available map layers, including aerials. The data are a combination of computerized addresses that are geo-coded to a specific building, office, or space on a campus. In cooperation with the Broward County School Board, floor plans were obtained and photos were taken on campus and from the sky, via a BSO helicopter. Every piece of information that schools store in their databases can be digitized and applied to a GIS system to provide public safety personnel with a visual depiction of what is facing them prior to their arrival at a critical incident.

In any critical incident, knowing whom to call, where to respond, and how to gain access is crucial. Even if the deputy is not familiar with a given school campus, he/she will be able to access street/parcel level maps, detailed floor plans, aerial photographs and interior photos. Primary and secondary perimeter points and staging areas are pre-designated so that supervisors and dispatchers will instantly know the best places to send responding emergency units. The program includes predetermined command post locations, the closest spot to land a helicopter and a place for parents to gather. A list of all other police agencies and hospitals is also included, as well as hazardous materials information.

Response to the CD has been favorable. Tactical response experts say the CD has proven invaluable in the event of a violent incident on campus, but it will inevitably be useful in other situations, as well. For example, if a school's security system detects midnight intruders, deputies will know how to best approach and apprehend the burglars. If a young student is missing, deputies will have emergency after-hours contact numbers for school officials.

However, significant hurdles remain. Updating the infor-



Operation Safe School project depicting aerials, maps, and floor plan for North Andrews Garden Elementary School.

mation as it evolves currently requires the creation and redistribution of the CD to the officers. This method is time consuming and limits the frequency of providing updates. As part of the evolving Enterprise GIS, the BSO is implementing ESRI's ArcIMS (ESRI, 2004) platform. This platform, referred to as a 'thin-client' solution, provides Internet capabilities to the Department's GIS Unit. The web-based mapping interface will allow BSO to collect, store and update the information in a timely manner. The system will also allow users to edit features such as setting up primary command posts or helicopter pad landing zones. The Internet functionality is being combined with wireless access for the first responders' laptops. The officers' computers are equipped with Verizon Wireless CDMA 1xEVDO cards. With a live connection, the users can access the most recent data available to the department.

Homeland Security

The GIS Unit is advocating the development of a *Strategic GIS Technology Plan for Homeland Security*. This plan is intended to address the implementation factors needed to fully utilize the GIS potential. In its early stages, a 'Technical Homeland Security Work Group' would address the following factors.

Once CATS for ArcGIS 9.x is available, the GIS Unit is planning to develop a 'thin-client' mapping application solution that utilizes CATS/JACE within a web environment (ESRI's ArcIMS platform). Other GIS/Mapping technologies being assessed are ArcWeb Services, Google Earth, and others to be reviewed at the 25th ESRI International User Conference. The intent is to allow first responders to access the information in the field rather than relay the information indirectly by radio dispatch. Also, first responders will have the visual information needed to deploy resources quickly and effectively.

Next Generation: Wireless Technology - FCC Phase II

The GIS Unit is also examining how to best utilize GIS for Emergency 911 response, particularly in the face of new federal legislation requiring the ability to determine the exact latitude and longitude location of wireless E911 calls.

The public safety community, embodied by several national level professional organizations –National Emergency Number Association

Implementation Factors:

1. Assess the usefulness of geospatial information for the purpose of Homeland Security. This would require the development of matrix indices depicting which GIS layers are mission critical and to establish procedures regarding data coordination, data updating, and data sharing between internal/external entities.

2. Assess the security implication of sharing critical infrastructure data. Of particular concern are the federal and local sources of geospatial information. Geospatial data and information are useful for identifying various geographical features of U.S. locations and facilities, as well as characterizing their important attributes. Although these agencies produce and publicly disseminate such information for a wide range of beneficial purposes, the risk also exists that some types of geospatial information could be exploited by terrorists. One of the issues needed to be addressed is developing security measures to provide this information solely to first responders.

3. Increase interoperability of resources to better regionalize responses to emergencies and homeland security. This will require the establishment of data/mapping standards, utilizing best practices in regards to technology and coordination efforts.

(NENA), Association of Public-Safety Communications Officials (APCO), and the National Association of State 911 Administrators (NASNA) -- united in 1994 to officially lobby the FCC for service parity between existing wire line E911 systems and wireless services. They requested wireless subscribers have the same level of service currently provided to wire line subscribers. The result of their efforts was the FCC's "Notice of Proposed Rule Making" (NPRM), or FCC Docket # 94-102.

The magnitude of the technical challenge became evident to the communications industry, as well as the 9-1-1 specialists, who were not previously involved, as soon as the NPRM was released for comment. The result of these comments led the FCC to release a "Report and Order" that identified several phases of implementation, occurring over a specified time, to allow appropriate technological adjustments to bring wireless service up to par with wire line service.

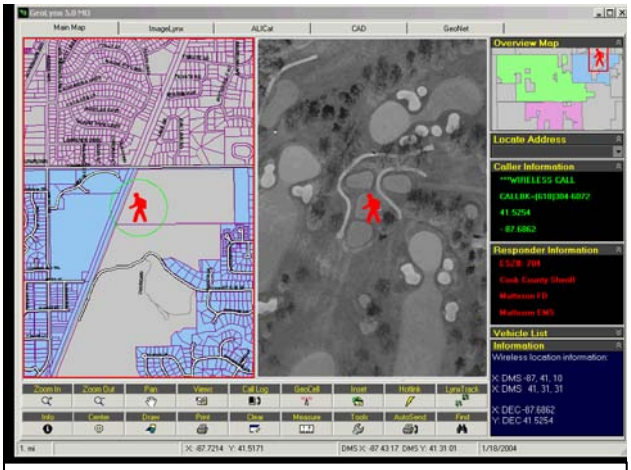
The FCC's wireless E911 rules require wireless carriers to begin transmission of enhanced location information in two phases. Phase I requires carriers to transmit a caller's phone number and general location to a Public Safety Answering Point (PSAP). Phase II requires more precise location information to be provided to the PSAP.

To make sense of FCC's wireless Automatic Location Identification (ALI), the call location must be located and plotted on a map. Plotting the location, along with the existing streets and addresses, electronic serial number (ESN) boundaries, and similar "background" information, will allow the call taker to quickly determine the location of the call. The background information should include the street centerlines, railroads, water features, ESN areas, city boundaries, county boundaries, emergency service agency locations, and other information.

A recent National Emergency Number Association (NENA) Critical Issues Forum identified key concerns of GIS technology in the PSAP as being data quality, integration, and data maintenance.

At BSO, the GIS Unit has developed a GIS infrastructure that will support Phase II. Working in cooperation with Motorola, BSO is currently researching potential mapping applications associated with Phase II. For example, the ability to transmit Phase I wireless 911 cell tower and sector coverage areas, as well as Phase II wireless E911 call locations on a deputy's laptop which also could also show map layers such as streets, parcels, waterways, and aerial photography.

The next component to add to Phase II is the potential of integrating tools like ALOHA or CATS within an E911 Wireless Dispatch Mapping program that can be utilized by BSO's first responders. The goal is to locate the E911 caller's location on screen and obtain the required information where these tools can be deployed such as overlaying a chemical plume dispersion layer in relationship to the E911 call and the area of impact.



roGeoComm's GeoLynx demonstrates the use of mapping depicting a PSAP Wireless Phase 2 caller.

Lessons Learned and Recommendations

The overall mission of the BSO is to develop an interoperable enterprise GIS that efficiently and effectively uses geographic technology to protect and serve the people of Broward County. To that end, the goal of the GIS Unit is to continue in enhancing mapping technologies that support BSO's ability to effectively address natural disasters, accidents, and other

types of major emergencies, including terrorist incidents. These best practices help in creating an enterprise solution in designing a geospatial infrastructure needed to prepare, respond, mitigate, and recover from both man-made and natural disasters. The success lies in terms of integrating various geospatial technologies, disparate databases into the business process to create a 'one-stop' interface to query, map, and report information efficiently and effectively.

To date, BSO's GIS infrastructure includes the development of a comprehensive Enterprise GIS Data Warehouse containing nearly 9.5 million records from disparate databases. Integrating the GIS Data Warehouse with ArcSDE, ArcIMS, and ArcObjects, the GIS Unit has created a 'one-stop' shop environment for querying, analyzing, and mapping public safety information quickly and efficiently.

Clearly, BSO has had a long history with computerized programs and software solutions to deal with both man-made and natural disasters. They have emerged from an organization that relied on stand-along programs (such as ALOHA) to an organization that seeks an integrated GIS capable of responding anywhere or anytime.

To optimize the Enterprise GIS in the near future, the organization is considering a number of important issues.

An accurate analysis of the current BSO systems for disaster management is difficult, due to the fact that the majority of the work completed thus far has been "scenario" analysis, and not an actual event. Lacking the ability to compare the results with real quantified losses or impacts indicates that the system is operating in a speculative mode. The system must continue to put its faith in the algorithms developed by the application architects. Refinement of the systems to reflect local conditions will need to occur as event analysis occurs.

The lessons to be gleaned from the analysis of this system are many. On purely technological grounds, the analysis of the available tools and methods is critical. The integration of these departments and the ability to incorporate GIS into a multitude of uses effectively and accurately is equally valuable. As the opportunity to respond to large-scale emergencies arises, we will be better equipped to evaluate and transform our technology.

ROADMAP AHEAD

1. ***Invest the GIS Unit with the authority of being the agency-wide 'custodian' of mapping technology and the spatial data steward***. The GIS Unit will be responsible for promoting educational awareness of enabling GIS technologies, serving in a technical advisory capacity on Homeland Security/Disaster Response initiatives/meetings/committees, developing technical roadmaps that represent best practices currently in use by public safety agencies.

2. ***Sustain funding support via executive management*** **-** needed to integrate best practices in utilizing GIS technology for public safety purposes. Funding will be based upon priorities set forth by the Sheriff and/or executive management.

3. ***Develop an Infrastructure that is Interoperable - Policy to promote Integration*** **-** Many government agencies and other organizations have been creating and maintaining spatial data for decades, making the United States the most geo-data rich country in the world. However, much of this data is trapped in information silos isolated within departments and organizations. To implement homeland security without costly replication of data will require the type of data integration provided by GIS as well as agreements that inventory and allow access to data by many jurisdictions in a controlled manner.

   It is recommended that a *Strategic GIS Technology Plan for Homeland Security* be developed. This plan is intended to address the implementation factors needed to fully utilize the GIS potential, including interoperability, flexibility, and scalability. This plan also outlines the level of service required, as well as where funding sources are identified and sustained. This plan would be adopted agency-wide as the technical roadmap for the utilization of GIS which includes standard operating procedures, use of standardized mapping technologies, and procedures to ensure proper data management.

4. **Manage Access to Data - Policy to promote Data Quality -** The creation of accurate and consistent data standards must be kept to insure the veracity of the data provided. Effective response by safety personnel can only be assured when they have accurate information to act upon.

5. **Develop Standard Operating Procedures to better regionalize responses to emergencies and homeland security - Policy to promote Data Sharing/Updating -** The ability to provide data to everyone who needs it is of utmost importance. At the same time, the ability to secure and protect sensitive data cannot be overlooked.

6. **Increase awareness and capacity to use these tools through Training and Technical Assistance Workshops -** The potential benefits of GIS can only be realized if the personnel involved are properly trained to use it. Understanding the benefits of the system will increase the level of interest among potential users.

7. **Build Relationships -** Data coordination and emergency response planning efforts have an added benefit. These activities build relationships between people in agencies, departments, and organizations. An old bromide of emergency management is that "people at the scene shouldn't be exchanging business cards." The process of gathering data develops relationships between people who would not necessarily have any reason to interact except in an emergency.

8. **Develop Thin-Client Solutions (Technology) -** The implementation of Internet accessibility coupled with wireless access will greatly enhance the potential of the system. The advantage of this system includes connectivity to the latest data, capacity to receive a broader range of information, ability to collaborate with others, and the capability of providing data updates to the GIS Unit.

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