Report to Emergency Services Foundation

‘Investigating use of GIS in response to the attack on New York City’

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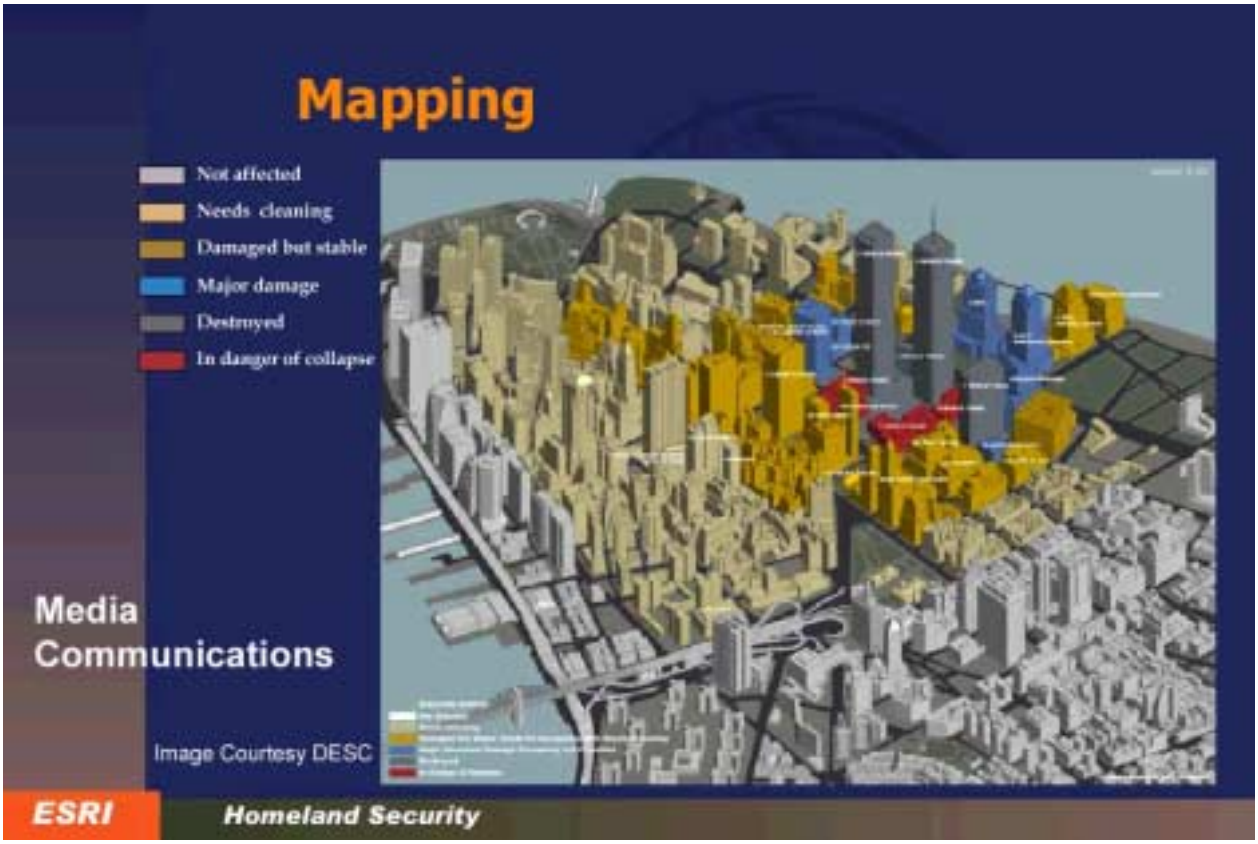

3D Profile of New York City communicating
location of damaged and destroyed buildings
(Source – ESRI CD “GIS Solutions for Homeland Security”)

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Acknowledgements

I would to thank the Victorian Emergency Services Foundation for the opportunity to investigate issues important to the Victorian community. Recent events in Bali have highlighted the need to be fully prepared in reacting to an unforeseen event.

I would also like to thank the people that assisted me in setting up the schedules of visits and interviews. In particular Jim Hall and Nevillyn Parsons in New York helped greatly in arranging meetings with people and organizations that would otherwise have been difficult to access.

In Melbourne, Neil Bibby encouraged me to pursue the scholarship, Alan Rhodes assisted in the preparation of the application, whilst Steve Jacoby and Duncan Brooks helped in providing initial USA contacts.

1. Executive Summary

Geographic Information System technology (GIS) was used extensively during the World Trade Center response and recovery. As part of the operation a GIS facility was established in the New York City Operations Center. The Center provided a stream of map based information and services to emergency management organizations and others. There was a need for a variety of information products such as the best access routes for emergency vehicles, the locations of hospitals, the status of water, gas and electricity supplies and the area covered by potentially toxic dust clouds. Development of these products was achieved using GIS technology.

The striking thing about the NYC GIS operation was the ease and speed with which it came together and functioned effectively and on such a large scale. Even though the original Emergency Operations Center housing GIS technology (being alongside the World Trade Center buildings) was destroyed, a replacement site was found in a nearby warehouse and the task of building a GIS from the ground up was begun. Yet the facility was able to begin functioning within days.

How was this possible?

Because the local emergency management and GIS industries had prepared on a number of fronts:

- Government organizations at all levels had planned for and prepared for the use of GIS in emergencies
- The principle of integration and cooperation had been engendered via a number of local initiatives
- Personnel contacts had been established between GIS specialists through local user groups
- Local industry such as utilities had been engaged to supply critical data sets
- The GIS had been previously used at emergencies so that processes, procedures and applications had been deployed and their benefits understood and
- The immediate and willing support of industry to supply hardware, software and services.

There are significant differences between the situation in New York City prior to the World Trade Center attack and the current situation in Victoria. The coming together of a wide range of spatial information experts using the latest software and techniques, accessing comprehensive integrated GIS data layers, using high speed networks to communicate with emergency managers, the media and public, whilst supporting on-site personnel is not possible. The pre-arrangements and infrastructure are not in place.

On a positive note Victoria is well placed to quickly remedy some of these shortcomings. All of Victoria's Emergency Services are using GIS to varying degrees. Some have a substantial capacity with specialized expertise in place whilst others are just beginning to become involved with the technology and have a limited capacity. An active Emergency Services GIS User Group, the first in Australia, already exists. Victoria's framework datasets, the basis for integration of information products are considered as good as any in the country.

This report documents the use GIS in the World Trade Center response and recovery. There are several over arching recommendations such as deploying the technology as far as possible into the hands of emergency management workers whilst there are many specific advisory notes to be found in the interviews with New York GIS workers and notes from papers given at an Emergency Management GIS workshop in San Diego. All of them have relevance.

GIS can make a difference. We must begin to improve our GIS capacity as soon as possible.

2. Major recommendations

Victoria's Emergency Services should build a coordinated approach to the development and use of spatial information.

Emergency Services should be freed from the current constraints in accessing state government data

GIS technology should be deployed into the field as far as possible into the hands of emergency management workers and their immediate support staff

Local government, utilities and private data suppliers should be engaged to supply information vital to emergency management activities

A mapping and information response support facility is required capable of deployment into several identified metropolitan and regional sites; flexibility should enable deployment into rural and regional Victoria

3. Introduction

Geographic Information System (GIS) technology collects, manages and analyzes large volumes of spatially referenced (map based) data and information. GIS provides a convenient means of communicating a range of information via a map and can help solve complex planning and management issues.

On the 11th September 2001, terrorists attacked and destroyed the World Trade Center in New York City (the incident is referred to as 9-11 throughout this document). A range of information technologies including GIS were established to assist in the response and recovery operations. GIS provided a stream of map-based information products to a variety of audiences for a variety of purposes. Information layers such as buildings plans, aerial photography and infrared imagery were created and collected to produce a multitude of maps based information products. The types of maps produced include access routes for emergency vehicles, the locations of hospitals and the status of water, gas and electricity infrastructure in the areas surrounding the World Trade Center.

The Victorian Emergency Services Foundation sponsored a study tour in July 2002 to investigate the use of GIS during the response and recovery phases of 9-11 and develop a understanding of the programs and processes that have been put in place in the past twelve months. The major activities in developing this understanding were attending a conference involving a major GIS software supplier, ESRI, visiting developers of major web site deploying national emergency management information and visiting a number of organizations and sites in New York.

4. About this document

There is so much information to be digested that I have had difficulty in putting the entire report into a logical format. The report begins with a description of the GIS operations in New York, then lists activities occurring since 9-11 by various levels of Government and finally there is a narration of the most pertinent points of view from conference speakers and interviewees.

Recommendations are enunciated in three areas. All encompassing recommendations dealing within systemic issues can be found in Section 2, next there are many advisory notes and suggestions found in the summary of technical papers and personal interviews, and lastly Appendix 1 lists the various items to be considered in establishing a GIS support facility for major operations.

Much of the information I have collected and collated is in the form of power point presentations, technical papers and articles. The best information resources on 9-11 and GIS can be found the list of Recommended Reading in Appendix 2.

5. 9-11 GIS response to World Trade Center attacks

5.1 An overview of the information management regime for emergency response in New York City before and after the September 11 World Trade Center attack

Background
The United States of America believed it was well prepared for all likely emergency scenarios. Prior to the disaster of September 11 a number of measures had been taken by the United States Government to ensure that emergency services would be efficient and effective in the treatment, conclusion and follow up of an emergency situation (including legislation to deal with situations caused by weapons of mass destruction). Many State and local governments also had comprehensive emergency response plans in place. Key elements of these measures particularly relevant to the September 11 attack are set out below.

Federal Response Plan (FRP)
The FRP (published to the web in September 1999) sets out the national emergency response and recovery role. The main objective of the FRP is to provide a structure for systematic, coordinated and effective delivery of federal assistance to address consequences of emergencies.

The FRP:

- outlines when, and what level of, Federal assistance is available to States, including both the immediate action at the time/threat of disaster and procedures to speed return to normal and reduce damage from future occurrences
- controls deployment of the Federal Emergency Management Agency (FEMA), Emergency Response Teams (ERT), Emergency Operations Center (EOC) and other subordinate bodies; and
- provides for the coordination of effort at state, federal and local levels.

Federal Emergency Management Agency (FEMA)
FEMA may deploy and direct federal agencies/liaison officers to a state emergency operations center to assess the emerging situation (the response sequence is initiated at the local level, and escalated to the state, which seeks federal assistance through the office of the State Governor if necessary). FEMA includes the National Emergency Coordination Center (NECC) which continually monitors potential disasters and emergencies.

New York City Office of Emergency Management (OEM)
In an executive order of 1st April 1996, Mayor Giuliani of New York City mandated a vision for an integrated approach to emergency response, with six types of emergency explicitly identified:

- Y2K related disruptions
- A strike by transit workers
- Hurricanes and coastal storms
- Extreme Heat
- Winter heat
- Acts of terrorism

The Office of Emergency Management (OEM) was created as a result of this order. It is a 24x7x365 agency operated by experienced communication officers. It utilizes the media to inform the public, before, during and after events - "Keeping the community leaders and residents abreast of the issues concerning them most". New York Mayor Giuliani, commenting on the opening of the OEM center noted: "more and more of the emergencies occurring in this city today demand the coordinated response of many city agencies. Consolidating the emergency management functions will institutionalize a comprehensive approach to handling emergencies. The structure of this office will not only ensure accountability, but will also help improve coordination and communication among city agencies."

Since 1996, the OEM has prepared a range of generic contingency plans:

- Severe summer and winter weather
- Biological and chemical terrorism
- Aviation disasters
- Mass casualty and Mass fatality situations
- Transportation and accident
- Hurricanes and flooding and
- Utility disruption/emergencies.

The Unit has also responded to a range of specific significant events:

- Conde Nast Building scaffolding failure, July 1998
- Crash of Swissair Flight 111, September 1998
- Tropical Storm Floyd, August, 1999
- Crash of Egypt Air Flight 990, October 1999
- New York Coliseum collapse, May, 2000
- State Street, Brooklyn, gas explosion, July 2000 and
- wide-scale power outages, summers of 1999 and 2001.

Frequent drills are run for all emergency services staff to prepare them for all possible emergency situations, based on the generic contingency plans set out above, and informed by experiences in the actual event responses set out above.

5.2 NYC emergency response information management prior to S11.

Prior to S11 the OEM was progressively building a coordinated approach to exchange and management of the broad range of information necessary for effective emergency response, with a strong focus on spatial information to underpin operational processes.

Specific initiatives included:

- the NYC GIS Utility, to act as the primary agent for interagency mapping and Geographic Information Systems (GIS) coordination, and to increase the use, quality and availability of data and continue to ID, reformat and publish spatially based information.
- The GIS Framework (NYC Basemap) which contains information on building and property alignments and addresses, administrative boundaries, road centrelines, and water assets, collated from a broad range of sources. Achieving this required major coordination between a number of different departmental agencies and will require ongoing maintenance to improve the accuracy of the datasets.
- A common registration, coordinate system, datum, zone and units for all required spatial information. This entails extensive arrangements, based on detailed policy development, for data sharing agreements and movement/amalgamation of datasets from several agencies to provide a unique, accurate database for use by all.
- Development and deployment of map based web applications, including:
    - Everyone Map - simple, common display and query interface
    - CapMap - current/future capital improvement projects
    - EMOLS - Emergency Management On-line Locator Server, used to update the public of the availability of utilities, access to regions, asbestos contamination, destruction etc

Despite the severity and frequency of the emergencies occurring during this period, development and implementation of genuine, single, authoritative information resources, available to all parties involved in a coordinated emergency response, remained difficult, with technical issues compounded by prolonged interagency negotiations. Consequently, although the required information, communication and coordination framework was defined and agreed to, actual progress towards achievement of coordinated information management remained slow.

5.3 NYC emergency response information management during S11

Shortly after the two World Trade Center towers were attacked the separate premises of both the NYC GIS Utility and the OEM were abandoned as buildings collapsed onto or around them. Officers retrieved backup information, relocated and obtained new equipment. However, it took several days to establish real time coordination of task forces and resources. It soon became evident that the scale and severity of the attack could not be addressed with the existing 'in principle' commitment to coordinated information management. Specific issues were:
Large numbers of emergency workers from other jurisdictions, having no local knowledge, were heavily dependent on maps and related information resources for directions, work scheduling, locations of medical and other support facilities, and locations of hazards.

The damage and outages to individual utilities and assets compounded and crossed over to other utilities. The lack of telecommunications hampered all efforts, while the lack of information on telecommunications infrastructure information hampered attempts to establish telecommunications. Worse still, lack of knowledge of extent of damage and outages to other utilities, particularly water, gas and electricity, meant the attempts to rebuild were often poorly planned and/or unable to be implemented. In particular, repair crews were constantly hamstrung by their lack of knowledge of underground fires, flooded sub-structures and gas and other toxic/hazardous areas. For example, while it was known that there were more than twenty fuel stores each containing in excess of 25,000 gallons within the immediate vicinity of the attack site, the location and details of each tank were not available for several days.

Management and control of access to hazardous areas was particularly difficult, and made more so by the need to determine, and then communicate, constantly shifting access perimeters to thousands of emergency workers and millions of concerned civilians. Websites became key means of information dissemination, with people not able to directly access the sites being relayed the information by a variety of means, from pagers to public radio and television broadcasts sourced from the websites.

In addition to the urgent need to coordinate existing information resources, a flood of new information had to be captured. The locations of temporary morgues, medical facilities, heavy equipment, access/haulage routes, and the status of variable elements such as fires, flooding gas plumes and the like were monitored, integrated assimilated and broadcast.

Ready access to GPS (Global Positioning System) based information was not available due to the 'canyon' effect of surrounding buildings masking satellite signals. The location of a range of utilities, where intact, was used to build up a de facto locational grid and identification system allowing work teams and resources to be deployed.

Despite the advantage of having taken the steps toward a coordinated information management system resource, significant resources were still devoted to identifying and liaising with required information providers in a broad range of utilities.

Information products developed and published had to be consistent form and content. To ensure that the broad range of workers had access to the same information, standard information resources were devised, using information from multiple sources.

Despite the relatively high level of preparedness and the existence of a range of previously prepared information products and services, new information products had to be developed. There was a clear need for a flexible capability to identify and produce information services for completely unanticipated requirements and circumstances.

The overall result of these pressures was a collective realization that it was imperative to establish a coordinated information management regime. Officers in a broad range of public and private sector utilities, agencies and businesses bypassed the incomplete implementation process (with and without authority), and immediately provided information, using protocols, and processes based on the work done to that time.

The outcomes of this 'ad hoc' coordinated information management model included:

The coordination and management of approximately 100 staff, from three levels of government, the private sector and academia, at multiple sites having different hardware and software platforms, and differing skills and knowledge levels.

The Center coordinated the interaction with over 75 organizations who were providing or receiving information
1,800 separate product requests were received, a significant communication and logistics exercise
Over 5000 paper maps issued during the response and recovery activities

5.4 Lessons learned

The world Trade Center attack of September 2001 was followed by the crash of American Airlines Flight 587, November 2001. The response to Flight 587 demonstrated that many lessons had been learned, with positive results. Within hours and onsite coordination facility has been established, acquiring information directly from remote sources and field workers, and effectively integrating and distributing information.

Since then, the opportunity to fully review the lessons of both the World Trade Center and Flight 587 has been taken. This section covers the main conclusions of that review and assessment.

Despite the level of preparedness, and the vision of and commitment to 'an integrated approach to emergency response' the clear and overriding lesson from S11 was the need for coordinated information management. Mayor Giuliani provided fourteen key recommendations in response to the lessons learned, five specifically dealing with information coordination, and two dealing with development of more effective information systems and analysis:

- Congress should enact legislation to permit and encourage information exchange between federal, state and local government
- Emergency management offices should be established in all cities and states
- Each OEM should have an Emergency Operations Center to coordinate response and communication
- Establish a Metropolitan or Regional committee on counter Terrorism to coordinate regional efforts to fight terrorism and prevent terrorist attacks
- Establish a Regional Counter Terrorism Database to coordinate intelligence from local, state, and federal authorities and law enforcement within a metropolitan region
- Establish a "Syndromic Surveillance" Information System to monitor unusual increases in calls to 911 on a real-time basis, categorizing these by specific symptoms and their corresponding illness, and allowing for rapid response
- Establish a Public Health Information system to monitor area hospitals for immediate follow up and investigations by physicians, public health specialists, and law enforcement agents

Other major conclusions were:
Although technical and technological constraints (hardware and software differences, incompatible data structures, datums and coordinate systems) did impact on the ability to exchange information, the primary impediments were administrative and political. There was a clear need for comprehensive and binding information management environment, accepted and supported by all participants.

The value of spatial information was recognized. Within a short period of term, the central role of spatial information in management and coordination became apparent, as evidenced by the renaming of the Emergency Management Mapping Center to the Emergency Management Data and Mapping Center (EMDC)

The value of the Internet for distribution of information and for clearly communicating the same information to hundreds of organizations and hundreds of thousands of people. The EMDC was able to focus on this as their single primary line of communication - a point of truth - and allow other organizations to distribute and disseminate within their own spheres of influence. This was true for the public and the media as for organizations directly involved in the response. Eventually the production of hard copy maps and documents was managed via a web interface, with organizations and individuals requiring maps selecting from pre-configured standard maps, then selecting specific modifications or changes.

N.B. This entire section was sourced from www.nyc.gov/html/om/html/2001b/pr340-01.html

6. Since 9-11 ... whats occuring in USA Governments

6.1 National initiatives

At the national level there are many activities occurring in order to boost the level of security for the American public. Foremost among these is the development of a National Department of Homeland Security.

The Department will have an organizational structure with four divisions: Border and Transportation Security, Emergency Preparedness and Response, Chemical, Biological, Radiological and Nuclear Countermeasures and Information Analysis and Infrastructure Protection.

Also of note is the National strategy for homeland security. The Strategy aligns and focuses homeland security functions into six critical mission areas: intelligence and warning, border and transportation security, domestic counter terrorism, protecting critical infrastructure and key assets, defending against catastrophic terrorism, and emergency preparedness and response.

Information is seen to contribute to every aspect of homeland security and a vital foundation for the homeland security effort. There is a growing awareness that a key component of homeland security will be GIS technology but the technology needs to be grown in a coordinated manner that can facilitate the information sharing across all levels of governments, private industry and citizens.

The National Strategy for Homeland Security has been published online and can be found at www.whitehouse.gov/homeland/book.

6.2 State initiatives - New York State - An example of state level initiatives

In 1996 New York State established a statewide GIS program. The program was based on an initiative sponsored by the Governor of the NY State to facilitate the effective use of GIS technology as a tool for planning, health, safety and economic development of the state. At this time a number of projects are in place and have been delivered. The program is administered by the Office for Technology and is delivered from the NYS GIS Coordinating body.

The basis for many of the programs is co-operation, data sharing, building awareness and creating GIS infrastructure. The program promotes the development and use of GIS across the state, the sharing of GIS data with citizens and between state and local governments, and collaboration between state and local governments and the private sector

A number of groups contribute to the management of the program including a coordinating body, advisory groups and work groups. The coordinating body establishes preferred standards and develops policy recommendations for the entire state, Advisory Groups provide a forum to air issues related to specific issues and work groups research and develop solutions to specific GIS areas. Work groups include finance, education, data co-ordination and standards. Recently Emergency Response was added.

Specific initiatives are of interest to Victoria. One example is the NYS GIS Clearinghouse, a repository of metadata and other information related to state geospatial programs.

The NY State Data Co-operative was established to provide a vehicle through which State and Federal Agencies, local Governments and not-for-profit organizations could easily obtain data from other members of the cooperative at little or no cost. All State Government agencies are required to join the cooperative. Members are required to supply their data to other members, including Metadata and contacts of their data holdings or they can share it via a data warehouse.

NY State Ortho Photo Program
The Center provides the entire state in digital ortho photo base free via the Clearinghouse; About 25% of the state is being collected each year; the resolution of the data varies; it matches the needs whereby it is higher in urban areas; Local Government can request higher resolution if they need it; Higher resolution photo's are 0.3m x 0.3m; The base level data is free but councils fund the higher resolution photography. The total program cost about $8 million

The NY Center for Geographic Information, the arms and legs of the NY coordination program, in the state capital Albany, were involved in the NY city response to the terrorist attack. They organized the capture of, processing and delivery of a number of data layers such as infrared imagery and aerial photography.

In the post 9-11 period the center has established as one on the working groups assisting the GIS coordination program, the Emergency Response working group. Within that group a number of subgroups are looking at individual issues such as the improved delivery of GIS information to the State Emergency Management Office during emergencies, improving coordination between federal, state, county and municipal governments, establishing standards and protocols for GIS and remote sensing data and the development of mobile GIS including guidelines for on-site mapping.

NYS is now endeavoring to acquire 'deep infrastructure' data such as cables, building plans, floor plans, and subway infrastructure. NYS is acquiring sensitive GIS data and placing it in a secure repository.

6.3 Local Initiatives

Local Government in the USA reflects the diversity of the American population as a whole. This diversity extends to GIS. Some local governments have very large and mature GIS systems whilst others are smaller and less well developed. Local government varies from very small rural counties with several thousand constituents to those representing millions of people as in the case of New York City which has approximately 8 million residents.

Local government delivers many emergency management services such as policing and firefighting. With the thousands of counties there is a diversity of technical platforms and products which extends into the world of GIS. Some of the smaller counties have developed sophisticated IT toolsets including using GIS for a variety of applications. Victorian Emergency Services are much larger than most local emergency services in the USA. From my observation American Emergency Services are technically more advanced than their Australian counterparts.

7. Itinerary - Notes from workshop, conference papers and interviews

(N.B. Points of interest and recommendations in this section are in *italics*.)

7.1 Sunday 7th July, San Diego - ESRI Workshop - Homeland Security

7.1.1 James Lee Witt - Ex FEMA President

Communication Co-ordination Collaboration
Sharing of resources across levels of Government is being encouraged
New Department of Homeland Security to be announced - $38 Billion in funding
GIS can show leaders where and why; President Clinton often used maps in situation analysis of disasters

7.1.2 Chris Schielein (ESRI New York) and Mike Wiley (Plangraphics Inc)

Worked in NYC OEM GIS Center during response and recovery

Office of Emergency Management New York - Their building WT7 collapsed, No back up data
All Agencies were represented in the OEM
The OEM GIS facility was operational by the Saturday following 9-11
Initial products were just simple maps of the World Trade Center site and surrounds
Data sources evolved - field operations, field data, old paper maps, CAD Drawings, thermal and LIDAR imagery
Digital orthographic photos were very important and useful
Maps of command posts, medical facilities, food and bathroom locations were produced
"Standard" legends and templates were created on the fly
Volunteer GISers were a major part of the response; NYC GISMO (the local GIS User Group) was a major supplier of labor into the facility
3D model of the city came from a private source and was used to visualize what was where in the rubble pile

After about 500 separate requests for maps it was decided to build an online map request system
A central server was established for data supply and was based on ESRI's SDE and SQL Server
Hardware in the mapping center included 20 workstations, 6 plotters, 2 servers
It was very important to create a historical record of the mapping products as they will be important in insurance claims, health and environmental assessments
The whole operation was undertaken on ESRIs GIS software Arc8.1
Now increased data sharing between agencies
There was an expanded use of GPS, wireless communications and the internet as the operation progressed

Lessons learnt:
GIS played a central role in the rescue and recovery effort
Develop a team of reservists knowledgeable in local datasets, and latest technologies
Establish standing agreements with suppliers such as Air Photo, software and hardware vendors
Anticipate types of map requests and develop standards
Establish a single integrated basemap and a robust data model
Fly early in the incident and fly often
Build links between all spatial and tabular datasets
Maintain offsite backups of critical data
Getting data into a sophisticated package such as SDE was difficult
Made many pdf's along the way which was very useful for historical purposes
Technology transfer and status updates was essential between shifts
Map request system was very useful - web based and used a map gallery of samples; a full time person was required to administer the position
Need for a data update tracking system as data was changing at least three times a day
Online map request system was very useful
EMOLS, the base application was adapted for use in communicating with the public via web maps
Data was migrated from shapefiles to SDE to keep things under control with regard to versioning data
Standard map documents were stored in one place
A mobile mapping center would have been beneficial to aid on site operations

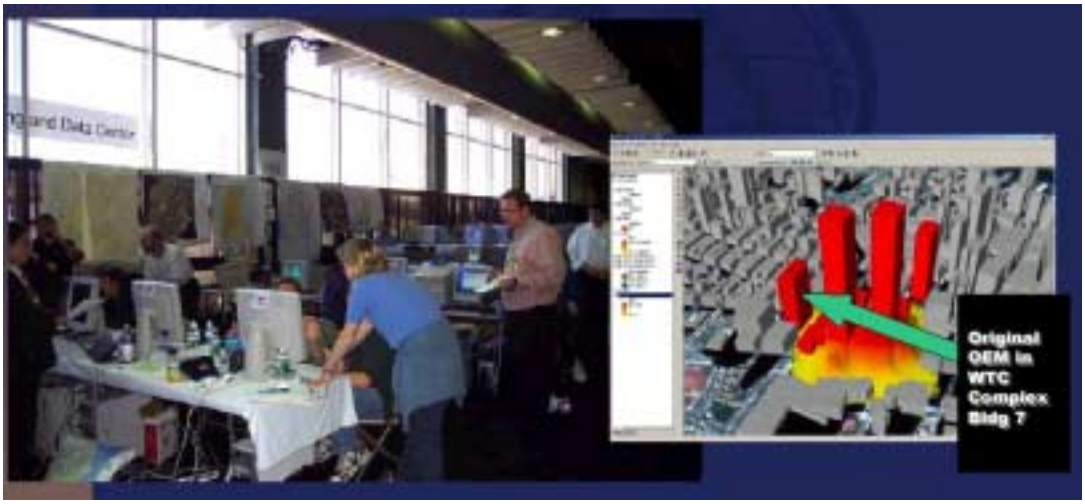

Figure 1. The OEM Facility – Preparing various spatial information products
(Source – ESRI "GIS Solutions for Homeland Security")

7.1.3 Dave Kehrlein: GIS Manager, California Office of Emergency Services
(Supported Urban Search and Rescue (USAR) teams in New York City)

Waterproof paper useful for field users
Affected area was divided into a grid with sectors to assist control and co-ordination across the site; Grid was placed over the ortho-photo's; The 6 figure national grid was unwieldy on a such small site
Map Mobiles would have been useful (there are currently 6 in California)
Field observers were used to map where various control centers were
Hazard maps were generated i.e. where glass shards or metal was hanging loose
There was a need to map where USAR teams had been as they would have just gone over and mapped the same things over
GPS didn't work very well in the urban canyons of NYC
Orthophoto's were the most valuable data source

Recommendations:
Adequate space required for on site GIS
Ensure you have access to the latest GIS tools
Train staff to work in EM situations
Standards published for data and naming conventions
Standard symbologies should be established
States need an EM remote sensing procurement strategy

7.1.4 William Henriques - GIS Coordinator, Agency for Toxic Substances and Disease Registry, Atlanta
(Responsible for mapping and analyzing buildings in the aftermath of bio-terrorism attack)

Sampling teams conducted field investigations on levels of harmful substances in air
Health communication experts conveyed methods for decontamination to NYC residents
Data very dynamic and non-standard because of different collection equipment
CAD drawings of buildings were used to map sites within a building and where different people had been working; The CAD drawings had to be cleaned up before they were useful in GIS

Anthrax
100+ postal facilities potentially affected by release of spores into processing machines
Specimens were not initially geo-coded
Tools were built to assist in geo-coding information as samples were processed at labs
Thousands of specimens were being brought in each day; Samples were inconsistently geo-coded
Organizational issues in creating Emergency GIS teams
Looked for competent GIS Users by Email
Sample maps on walls is a good way for users to be able to choose what they want; map templates should be ready to go before an incident
There is often the requirement for unusual data sets such as Ice Skating rinks, Companies with refrigerated vans

Lessons learned
Have a cadre of personnel and equipment ready to deploy to public health activities
Now is the time to identify resources useful in mapping activities
Technology is our friend: develop systems that provide real time access to critical information
Let those that know their own data maintain and share it
Use the GIS paradigm of data sharing in all activities related to homeland defence

7.1.5 Tim Walsh - Marin County Fire Department
(responded to the Pentagon attack as part of a National Incident Management Team for logistical support for the FEMA Urban Search and Rescue teams)

Getting data to map the pentagon was relatively straightforward
Building rubble is very difficult to map
Products produced included simple building plans, maps of last known locations of bodies, airplane trajectory models

7.1.6 Jay Devasundaram, Peter Bottenberg - GIS for Bio-terrorism Preparedness (Response to Anthrax in the Brentwood Postal facility)

Teams included Surveillance, Clinical investigations, intervention and education, environmental evaluation and Epidemiology Evaluation team, Postal evaluation and Laboratory team
Mapped environmental specimen locations, compared employee serology results to locations, evaluated sampling location quality
Integrated Sample Management and Analysis System used GIS to support Rapid Analysis and Response
Track patient movements in the facility, Sample/specimen analysis
Teams also involved in New York City response

7.1.7 Christopher Thomas - ESRI Organizational issues related to homeland security

Commitment to the GIS professional
Engage all Departments that are involved in emergency response
Develop a network of regional GIS Professionals - Inventory skills and expertise
Revisit GIS needs assessment; build disaster GIS from a solid foundation of framework datasets
A solid foundation will enable straightforward exchange of data
Undertake a data gap analysis
Standard data sets are required e.g. parking garages, building floor plans, public transport locations, daytime population locations, helicopter landing pads
Non-standard data sets may be required e.g. location of cold storage plants, skating rinks, refrigeration trucks
Applications are varied: waste removal, economic redevelopment, building safety

Lessons learned
Establish a network of regional GIS Staff
When working with regional agencies identify base layers from which all organizations can rely
Identify and develop mission critical data that meet applications, analysis and map/report output
Centralize storage of core data sets
Prepare and store maps and reports that reflect conditions and infrastructure after the catastrophe
Build a remote back up system
Establish a catalogue of standardized map products
Automate map request and tracking system
Test GIS during emergency drills including all Departments impacted by a catastrophe include local utilities and private sector
Develop data and symbology standards using National standards where possible
Establish data sharing procedures and exchange protocols
Identify processes and response protocols and develop GIS applications and analysis to support events

7.2 ESRI Conference 8th-11th July Notes, Summaries of papers

7.2.1 Bill Holland - www.geoanalytics.com

Vulnerabilities in the IT system: Data, networks, applications, people
Who and what are the threats
A range of security actions are appropriate - deterrence, prevention, interdiction, response, crisis management, restoration; GIS can be useful across all of the above areas

Data accessibility - getting the right data into the right hands
Over accessibility of data may be dangerous
Privacy, data sensibilities, data formats, viewer anonymity, target sensitivity
The secret is to create a trail of data access; Make data users "show their face"
Ensure that data gets to those who need it
System security is very expensive (best practice is dynamic so money must continually spent)

Stand alone GIS/Mapping utility for 1st responders
Lessons:
Incorporate discovery layers
Refine existing GIS layers
Local information is critical
Integration of State-Federal data is critical

Systems have been deployed with data packs; greater demand than anticipated

First iteration of response GIS has about 30 data layers including Colleges, pre-schools, earthquake faults
Second CD has previous fire burns, vegetation, hazmat sites, military facilities, locations of radiological devices including dental surgeries

Future implementation
Bi-directional data management; SDE, oracle, geo-databases
Tools include NOAA, Aloha, CAMEO (plume modelling software, etc)
MoUs and Copyright ensure data is not copied (good faith required)
Terror threat assessment not included on the CDs

7.2.2 Dorothy Albright - United States Forest Service - GIS and fire modeling

(Site can be found at http://geomac.usgs.gov/)
USFS wanted to create a one stop shop for fire data; there is an inability to access timely data
No central information infrastructure; little co-ordination or tracking of incident data

Solution
Web infrastructure
Tactical level ArcIMS application which will complement GeoMAC and FirePAS
There will be public and professional views of data including a scaleable fire data repository
Satellite dish to transfer maps of PDF's
Public is now demanding maps

Current issues: Functional requirements, system design, workflow protocols, build scaleable technology
Platform: ArcIMS, SQL Server 2000, custom user group

7.2.3 Phillip Worrall - Indiana State Homeland Security Group

In the aftermath of the Oklahoma Bombing GIS was invaluable
Principles upon which a new system has been built:
First responders will be local and therefore the key to success is having GIS data available locally
Rapid and accurate flow of information is essential
Digital map makers now follow the first responders to all large incidents; Responders and operational managers then need to trust the information experts

Effective communication co-ordination and collaboration is required
Be prepared to start over and throw old systems away at short notice

1m ortho photo's are available for all of Indiana
22 of 92 Counties in Indiana have given their data to the state response authorities
Work is required to access data from the energy and telco utilities (their data can be better than the Counties)
Leverage GIS: Uninterrupted, secure, on-demand supply
All of Indiana Government is an ESRI shop; this has advantages in procurement and interoperability
Local Risk Assessment: Inventory and assessment of local population and locations
Let's roll: Complete I-Team planning including budgets, Statewide or regional disaster, response teams formed (University and Utility staff included)
Utilities data needs to be protected and secured

State geo-spatial data clearing house:
Secure login
View GIS maps, select features within a buffer, distance, simple maps
On SDE, everything is handled server side

7.2.4 New York City - Maria Ormish

(Worked on the Deep Infrastructure Desk in the NYC OEM Mapping Center)

NYC is working with ConEdison, empire city subway to share data which is registered to basemaps
At Pier 92 they has 26 PC's, 2 servers, 5 plotters

- Deep Infrastructure Desk was organized to supply Utility information to Fire and Police. The DID:
  - Established Communications with Utility companies
  - Established the framework for data exchange
  - Interpreted the usefulness of the information for ES activities

Initial issues site issues which were analyzed:

- Potential for explosions
- Structural integrity of the buildings

Other DID activities included:

- Work with the utilities
- Dealt with legal issues relating to data disclosure
- Set up a secure computing resource for utility data
- Evaluated new technologies being introduced onto the Operations area on a daily basis

Products from DID:

- Outage maps
- Security for access to data
- Structural Building Plans
- Started by investigating local datasets for locating Freon Tanks, Fire extinguisher Units in the rubble
- Most products were delivered on top of ortho photo's and included the FDNY site grid of 75' by 75'

Software evaluated on the fly:

- Document management system (relied on ArcGIS)
- CART underground sensing
- MAYA animation of below ground level
- GPS use (not recommended)
- AutoCAD 3D modelling
- ArcScene

Lessons learned:

- *Outage management is not a core use of Utility data therefore their data was not quite right for EM use*
- *Metadata availability important*
- Additional security was required for access to the EOC
- *Direct access to the customers was difficult*
- *Flexibility in using data in multiple formats was required*
- *Canned products were very successful*
- *A single integrated database utilizing an effective data model was required*
- Operate as close as possible to normal procedures

7.2.5 Anthony Spicci

Missouri Task Force 1

USAR - Urban Search and Rescue teams at NYC searching the rubble for survivors and victims

A USAR team member deployed into the WTC took his own GIS equipment including a GPS, a lap top, Compaq IPAQ, ArcPAD and ArcView
FEMA uses GIS extensively on incidents although FEMA does not formally advocate it's use on site
The on-site work was pioneering; field work was undertaken on the IPAQ
All data was sketched or recorded and later cleaned
Data collected: Search area covered, Victim locations

GPS used to help locate people on the site

On ground activities were assisted by Imagery and building footprint maps e.g. instructions were given using GIS paddocks to go to the plaza level and look for victims
Digital floor plans were used to find alternative routes amongst the rubble

Problems:
Initial lack of local data
Handheld PC's weren't much good
IPAC needed to be ruggedized
No direct access to the NYC Office of Emergency Management who had the best data
Internet access was unreliable for data transmission
Collecting data in the rubble was challenging
Poor printing capability in the field
More aggressive data acquisition was required
Direct transfer of data via TV signal is being considered

Full time GIS would be a benefit to USAR teams

Figure 2. Urban Search and Rescue teams used various mapping technologies
(Photo courtesy FDNY)

7.2.6 Harvey Simon - NYC Environmental Protection Agency Coordinator (EPA monitored air conditions around NYC after 9-11)

Need for near-time processing of data for Operational activities, worker safety, public information
Multiple organizations were collecting EPA type data
There was a need for a central clearinghouse of environmental data
Early in the incident EPA collected non-standardized hard copy data
Need for definition of cartographic product and data report requirements
Need for effective internal and external data coordination and an ability to post to an EPA web site
Need to distribute data to responding agencies

EPA's office, being near WTC, was closed down; WAN and Internet was affected

An Access database for all EPA data was established; critical data was loaded from NYC-OEM
A data needs assessment was conducted resulting in the following:

- *Air sampling (Dioxins, Asbestos, PCB's, dust)*
- *Multi-media*
- *Operations data needs*
- *Management data needs*
- *Public information needs*
- *Geo-coding procedures were set up from monitoring stations*
- *Even though the database design was very simple, EPA started to get standard data sheets from different sources; A data import utility was built based on the standard forms*

Data went out to the public (http://www.epa.gov/wtc)
The platform was migrated to ArcGIS to make better maps and graphs

Lessons
Personnel contact lists should be in place and up to date
Should expect to work from another office
Communications architecture should be thoroughly investigated as different private providers were using the same hardware
Web-based email and Cell phones were critical communication technologies
Have good relationships with the hardware and software vendors
Data management strategy critical
Veteran staff using flexible skills were critical

Make data management and analysis integral to data collection planning processes
Establish roles for data management infrastructure
Replace all paper based field data collection with digital collection systems
Develop web templates before an incident i.e. didn't know how to communicate to the public possible spread of Dioxins and other toxins
Develop a secure extranet to share data
Develop a plan to rapidly acquire and use remote sensing products

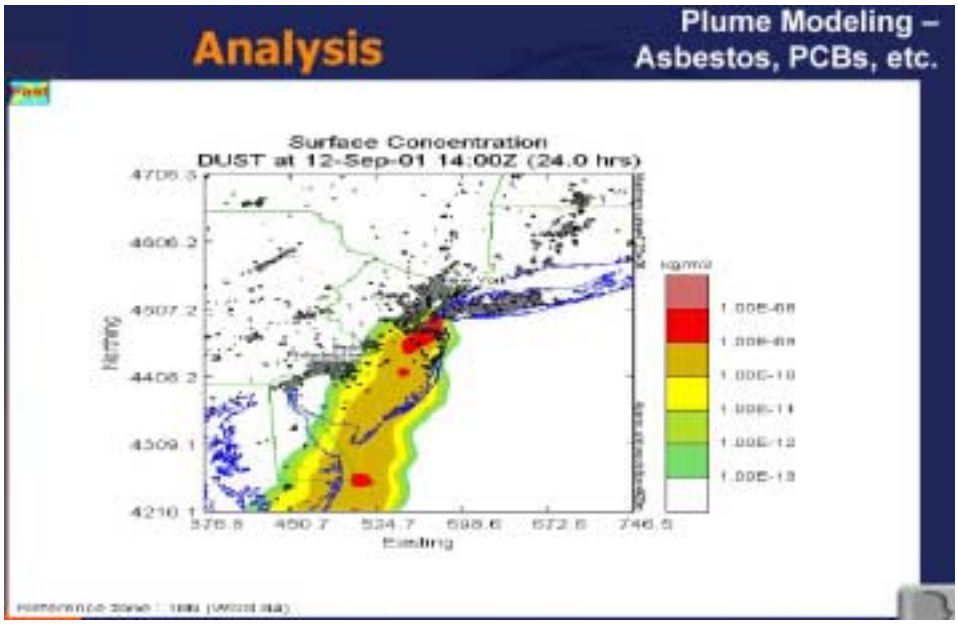

Figure 3. Analysis and modeling of toxic plume
(Source – ESRI “GIS Solutions for Homeland Security”)

7.2.7 Private mobile GIS/Mapping truck on display in the Public Safety Exhibition - "Michelles Mobile GIS"

Michelle is a privateer that rents a truck full of GIS equipment to whoever wants it
Truck is full of PC's, satellite communications
Has ArcView on board the PC's and Californian Base Data; Local data is chased when on scene
Michelle doesn't do any GISing himself; he can't afford the insurance; Governments and other responding organizations supply the GIS labor

7.3 Denver, July 15th-17th

United States Geological Service, Denver Federal Center

GeoMAC is a web site devoted to distributing wildfire information via the Web to Operations and the public; Wildfire information is received from many sources and locations, aggregated and re-distributed

7.3.1 Elizabeth Lyle - GeoMAC Web site developer

GeoMac is being developed by the USGS because they had the skills sets in the first place and others required the functionality
They work on behalf of the Bureau of Indian Affairs, Bureau of Land Management, National Parks, Fisheries and Wildlife, USDA Forest Service, National Oceanographic Aeronautical Administration
GeoMAC provides high quality interactive information to the public and wildland fire managers
The project is also supporting EPA first responders and a housing evaluation project along the Mexican Border States

GeoMAC Data Sources include:

- USGS shaded relief
- Roads come the National Atlas
- Perimeters come from various partner agencies e.g. BLM, in various formats
- The text fire report summary information comes from the National Interagency Fire Center in Kansas
- Data can be emailed or via FTP
- The small scale fire perimeter data is used by FEMA and those responsible for fire area rehabilitation

Development
Development of the site is directed by the National Interagency Fire Center e.g. what goes on the web site, to what accuracy, and decisions on who sees what
There are several other look alike portals using the base system such as South West GACC; this site is used by fire managers e.g. fire edge composites from AVHRR satellite images
Another site is the Rocky Mountain Co-ordination Center which uses the same tools/servers

GeoMAC includes a staff of 10 including a full time ESRI programmer; resources have expanded as the drought intensified and fires started
FEMA and OEM have arrangements with GeoMAC
GeoMAC runs on SDE, 2 Servers, had had 2million hits up to July;
The web site developers skill sets included professional Web designers and cartographers

7.3.2 Susan Goodman

Bureau of Land Management, Denver federal Center (a GeoMAC client)

The GeoMAC Group is managed by a committee represented by USGS, 5 federals and 2 state organizations
The Group organizes standards, common attributes, projections
GeoMAC has to deal with data being received in many projections and datums
To keep the website up and running takes about 1 hr per day
Before a fire perimeter is posted on GeoMAC, it is checked against MODIS and AVHRR satellite imagery for validity, ensuring that the reported Geocodes of fires are within the fire perimeter
There is an FTP site that fire perimeters can be downloaded
Most data is posted to GeoMAC as goodwill, in ESRI shapefile format, with standard attributes noting who collaborated, when, from what platform; Accuracy is +-30M

GPS's are used to collect fire perimeters, both Garmins and Trimbles; data is collected by aircraft, choppers, 4wd-bikes
USA uses 'reverse 9-11' to evacuate people with phone messages
Property data, which is used to estimate losses, comes from counties; these data are not always given freely and some counties do not supply their data at all, but the data does have location of houses on house blocks
Another product viewed was the communities at risk map; States were required to supply Federal Government with locations of "communities at risk from fire" and the results were substantially different from neighboring states i.e. one state reported every hamlet as being at risk whilst it's neighbor nominated none

Private companies are supplying mobile GIS equipment and onto the fireline; They are top quality systems and is the way of the future for supply of information technology on the fireground.

Uptake of GIS by agencies is inconsistent and there are few standards for data collection of fire perimeters

7.3.3 Sherry Durst - National Mapping Division, USGS operator
A developer building an EPA Toxic Response web application
USGS is preparing an ArcIMS response system for EPA designed to support first responders by locating a spill and buffering to locate a range of operational services and resources
The application is accessible on ArcIMS Internet and on CD through ArcExplorer to Federal Government Departments, States and Counties
It is password protected and not accessible by the public
The main uses/scenarios are to identify sensitive rural environments and how they are threatened from oil spills
The power for action comes from the clean water and pollution act
Data providers (~30 layers) all provided data freely, although some was provided only if satisfactory security was in place
The USGS provides the basic data sets/ contact lists, etc which are updated annually; EPA does this via it's contractors
At the moment the site uses shapefiles on ArcIMS because it is practical and easy to support
The site has ~30 spatial layers with attributes, all searchable e.g. stream gauges, RAWS, Equipment stores, location of trauma centers, water access points (photos associated)
The system has a large Metadata, Help files
The system is out of the box, standard ArcIMS

7.4 New York City 19th-26th July

7.4.1 NYC GIS Utility
Jim Hall - Executive consultant, Plangraphics Inc
The City GIS Utility is within the Dept of Information Technology and Telecommunications (DOITT)
Plangraphics is a major contractor to NYC and supplies about 60% of their GIS labor
DOITT has about 400 staff supporting 25,000 NYC staff in IT
The major areas of work for Plangraphics are developing applications, data and metadata
An important piece of GIS work was to create a BIN (Building Identification Number) which provides links to many entities e.g. several addresses on one lot, several lots on one address
NYC is a multi-platform GIS; Plangraphics supports and works with multi-formats such as Smallworld, MapInfo and ESRI

Major Works Areas
Develop a data model so diverse databases can connect
Collect/develop data e.g. Sambon Maps (Scanned building plans) to get locations of stairs, pipes etc, which are very useful for firefighters; other datasets include Landmarks and Historic Districts
From these datasets lots of information can be integrated e.g. views of fountains can be calculated when reviewing building permits for height restrictions
The Utility has developed several good applications including EMOLS, West Nile Tracker, Everyone Map, MyNeighbourhood (Web applications)
Analytical support services include: Re-engineering, Needs Assessment, Procurements, Identification of emerging technologies; Wireless applications, GPS and AVL applications

Developed a method of locating public pay phones and hydrants
API's are developed free for internal Government use which encourages standardized applications
The MyNeighborhood application looked good, a web mapping application that allows the public to develop maps of their own area
Pretty Map is a map template used by other GISers in NYC

7.4.2 Al Leidner - Director Citywide GIS, DOITT, NYC
(Leader of the OEM Mapping and Data Center during 9-11)

Emergency managers need geo-spatial information capacity in order to turn data into information
At 9/11 everyone died quickly but in a prolonged event such as bio-terrorism GIS may become a ilfe saving technology
Full data suites such as building plans may have made a difference
Full analysis was not possible during the early stages of the operation because data wasn't available
Throughout the incident the planning teams learned more and more about the data required and what could be achieved with it
Fuel tanks in the city are now being mapped
Before 9-11 data sharing with some utilities was good with some (Con-Ed) and not so good with others
Soon after 9-11 there was goodwill to exchange data but it's getting bogged down with bureaucracy now
All the EM exercises before 9-11 didn't include requests for GIS products - like those that were provided during 9-11;
Responders practice response but the information managers aren't engaged to practice information delivery
An important function at OEM during 9-11 became information liaison with responding agencies - 'what do you need?'
Proposed improvements for use in the field include making data more portable and usable at the incident site; This would be achieved using lap tops, CD's and Net-delivery
"Pathways of delivery" need to be in place
Mobile GIS - both pick up data and send back to a central server/database
NYC are looking to purchase 3 mobile GIS vans
During emergencies audiences for GIS products include scientists/modellers, incident managers, responders, media and public
NYC is using both stick and carrot in encouraging Utilities to supply data
Carrot: Provide them with framework datasets
Stick: In NYC Utilities use Right Of Ways to install cables, pipes, etc but they need permits because the City owns the land; NYC could make it difficult for non-cooperators of data supply
For infrastructure they are also acquiring data on high risk sites such as bridges, stadia and public buildings
GIS Labor for 9-11 was initially drawn from an Email sent to members of GISMO - NYC GIS Users Group; GISMO meet every 6 weeks and have about 200 members; Hours after 9-11 key GIS people were starting to meet
*** The majority of information providers for Emergency Management on the incident were GIS people; I.T. and other analysts were just supporting the GIS*
ESRI offered unlimited support in the form of licenses and labour early in the operation
SDE is OK but the data models are not mature

7.4.3 Tom Henderson, Bruce Oswald, William Johnson
GIS Program, NY State, Office of Technology, Albany, NY

The NY State Office in Albany, the state capital, seemed to be a Land Victoria equivalent
In '96 a task force was asked to generate a co-coordinated statewide GIS program; A number of projects are in place and have been delivered
The basis for many of the programs is co-operation, data sharing, building awareness and creating GIS infrastructure

NY State Clearinghouse
Website devoted to GIS programs: Working Groups; education, free data, free applications
Data Co-operative
All State Government and a number of not-for-profit institutions (e.g. educational) are members of a data co-op where data is shared, free of charge. State Government entities are required to join;

Members are required to supply their data, including Metadata and contacts of their data holdings or they can share it via a data warehouse

NY State Ortho Photo Program
NYS provides the entire state in digital ortho photo base free via the Clearinghouse; About 25% of the state is being collected each year; the resolution of the data varies; it matches the needs i.e. it is higher in urban area; Local Government can request higher resolution if they need it; Higher resoultion photo's are 0.3m x 0.3m; The base level data is free but councils fund the higher resolution stuff
The total photo program cost approximately $8 million

Co-ordination Group for statewide issues
The Group was set up to oversee state programs
Work groups that contribute include finance, education, data co-ordination, standards and now includes Emergency Response

NYS is now endeavoring to acquire 'deep' data such as cables, building plans, floor plans, subway infrastructure
FEMA arrived at WTC with larger scale data than NYS and OEM were using; They ended up using the better data and are looking at ways to better access high quality local data during emergencies
An advantage in delivery of information was that the EMOLS application already existed and could be adapted quickly
NYS is acquiring sensitive GIS data and placing it in a secure repository
During 9-11 there was a need for rapid contracting and establishment of air clearance for imaging aircraft
Thermal imagery of the rubble pile was heavily used although the 12-hr turnaround; FDNY suggested that 4-hr the turnaround time to be strived for

The Center for GIS assisted in the supply of data in particular remote sensing to the OEM during 9-11. The lessons learned here are taken from a presentation prepared by the NYS GIS Center.

Lessons learnt from 9-11

- *An integrated GIS database covering the site on an emergency is invaluable*
    - *Strong coordination and cooperation at the upper management levels of both government agencies and private or quasi-public organizations (e.g. utilities) is necessary to achieve this kind of integration*
    - *"Deep infrastructure" data is needed in urbanized areas*
    - *Hazmat information must be immediately accessible and identifiable by location – preferably in GIS format – both before and after an incident*
    - *Offsite backups of GIS databases are not just prudent but essential*
- *Timely Remote Sensing Data is valuable in major emergency events*
    - *Two levels of RS data is needed; Situational overview and accurately registered imagery for GIS*
    - *Fast contracting of RS Vendors is required*
    - *Rapid military flying clearances are required*
    - *Flexible deployment of RS technologies is essential*
- *Communication is critical*
    - *Designated points of contact needed for GIS and RS data coordination*
    - *The internet and FTP sites proved very useful in moving data and information among the responding groups*
- *Data Presentation: "Succinct but not simple"*
    - *Visual is better*
    - *Adhere to cartographic principles*
    - *Both digital and paper products are needed*
    - *Generic mapping and data templates required*
- *Mobile self-contained field units are needed for on-site deployment*
    - *On-site liaison with responders*
    - *Mapping/GIS production*
- *Training for designated emergency response personnel in GIS/RS*

- *Coordination required among local/state/federal agencies for inspection of buildings*

Observations from 9-11

- *Collaboration with the media can be a good thing*
- *The nature of a terrorist emergency poses special challenges:*
    - *No warning*
    - *Many potential targets*
    - *No knowledge of the end of the event*
    - *Requires tight security*
    - *Communication with the public critical*
    - *Legal requirement for crime scene forensics*
- *"An emergency is much more than first responders risking their lives. It is a complex, data-intensive operation that requires the full support of IT and GIS personnel who are practiced at working as a team"*

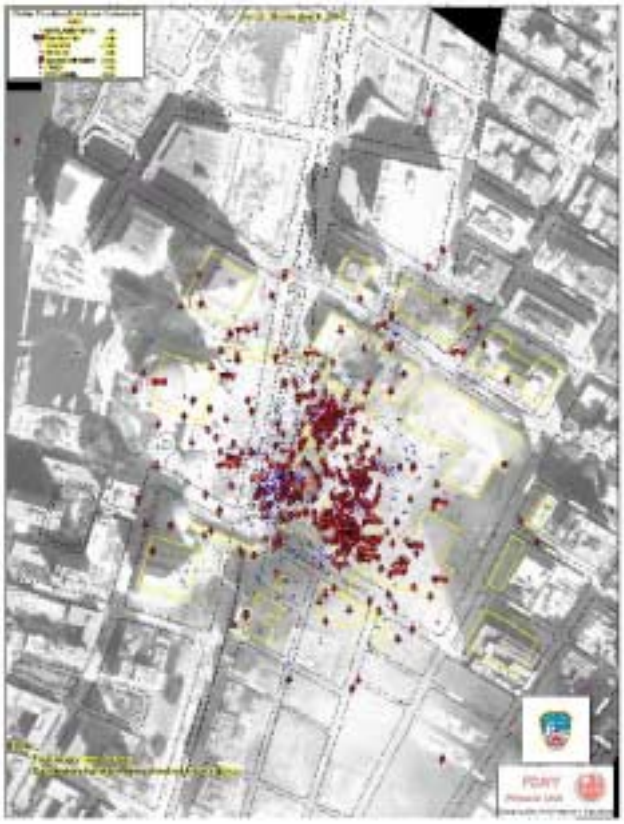

Figure 4. Orthophotography was very useful in the response and recovery effort.
(Image courtesy FDNY)

7.4.4 Roberto Olagasti - Deputy Chief Operations
SEMO (State Emergency Management Center), Albany, NYS

SEMO is responsible for all activities necessary to protect New York's communities from natural and technological disasters and other emergencies that threaten the state
GIS Mapping is a vital information component of the center
Initial risk mapping has been undertaken across a range of hazards
The Office has 1 full time GIS employee although there are several support personnel from the GIS center down the road from other state Government Offices including the NY State, Office of Technology
The Governor and emergency service managers all expect GIS products to be supplied as part of the state situation reports

7.4.5 Jim McConnell Director GIS
NYC Office of Emergency Management

OEM are in new facility under the Brooklyn Bridge after building at WTC was destroyed;
NYC instituted it's own Office of Emergency Management in '96 because of the size and susceptibility of NY to hazards
The OEM is a chartered Department in it's own right; The Department is small being about 100 people;
OEM is an "organizing" Department during emergencies; it ensures co-ordination between responding agencies; it actively monitors police and fire radio's to keep track of situations
OEM undertakes planning and preparedness for major disasters such as floods, earthquakes, hurricanes, storm surge and "active" incidents such as bio-terrorism
They have created a database that assists in the management of of emergencies e.g. heat related emergencies - old people centers, critical care, dialysis centers;
OEM is endeavoring to get datasets from Utilities; It's not happening yet but is a 5 year plan
Many of the datasets from utilities aren't GIS friendly and will take time for them to be made available for use in GIS
OEM is hoping to keep abreast of Homeland Security Issues but their role will be a response role rather than the prevention activities that many of the Homeland Security issues are concentrating on

OEMs role in WTC
There were no pre-plans with regard to setting up the GIS unit and there are still no people, software, data sizing, scoping guidelines; Building the GIS platform was all done on the fly.
A critical database was the GIS/CAD layer describing the infrastructure on each floor of the WTC; this was created by scanning paper plans and converting them into GIS layers; it took days + days to generate the file
The GIS was initially set up to save lives; it became very useful in the recovery phase
The new OEM office, an empty floor in a warehouse, has 10 empty workstations set aside for GIS
OEM runs software called E-team, a messaging/information management system which they are trying to integrate with GIS

Lessons learnt
If OEM ran 9-11 again there would be more electronic maps and less paper maps
Large paper maps are required in the field, but other users are being pushed toward using e-maps
It is hoped that GIS will never again have to be built on the fly, that applications will be in place, ready to go
The provision of 'standard' maps is very important, so that clients can pick products from a list
Local data from NYC was much better than that provided by Federal Departments such as FEMA; FEMA used the NYC data once they realized it was better than theirs
The current 'warehouse' – Day to day work is undertaken upstairs; downstairs about 150 idle PC's are ready for all the agencies that require liaison activities; GIS has about 10 workstations
OEM have exercises practicing response and include GIS requests in the activities
****A point for counter terrorism exercises in Victoria is that they don't include real GIS stuff - they probably would need it or find it useful practice for a real event*

7.4.6 Fire Department of New York (FDNY) - GIS Facility
Justin Baxter, GIS Manager,
David Litvin, Deputy Director Computer Support,
FDNY runs a GIS team of 6-8 people; they particularly support operators with tactical mapping; Their Chief particularly calls for detailed maps during events
Hydrant inspections are entered into the GIS database; Data is collected by firefighters who inspect twice per year
FDNY are using NYC's Nice Map, the template and base used by the City
Map were soon required assist in communicating the layout of the site
Data was useful in the following order:

- *Ortho-photos*
- *Planimetric maps*
- *Infrared imagery*
- *Lidar data*

Initially and throughout the operation aerial photography was useful; After some time this was supplied ortho-rectified
At the end of the first week building outlines were being overlayed on top of the rubble, with common building names as attributes
About the 4th or 5th day a 75' grid was created over the site and sectors were created (4 divisions)
Infrared Imagery was useful to determine where fires were still burning in the pile
There were several dangers in the pile such as freon, PCB's and a high level of Carbon Monoxide
Daily imagery supplies included oblique photo's from choppers and thermal imagery
Contractors did the rectification of IR imagery
As the incident progressed mapping took on new functions for the FDNY such as mapping car parks and bio-showers, identifying restricted zones
Incident commanders were communicating directly with the GIS Group, asking for products
Data in the FDNY GIS now includes Consulates, Police Districts, Aircraft fuel lines to the Airports
The FDNY is considering the use of Mobile GIS Units which would include SDE, a Web Server and ArcIMS along with Wireless Communications to the fireground
FDNY sees the use of Drones as preferable to putting people in helicopters at risk; They are very flexible and could be deployed with a range of sensors

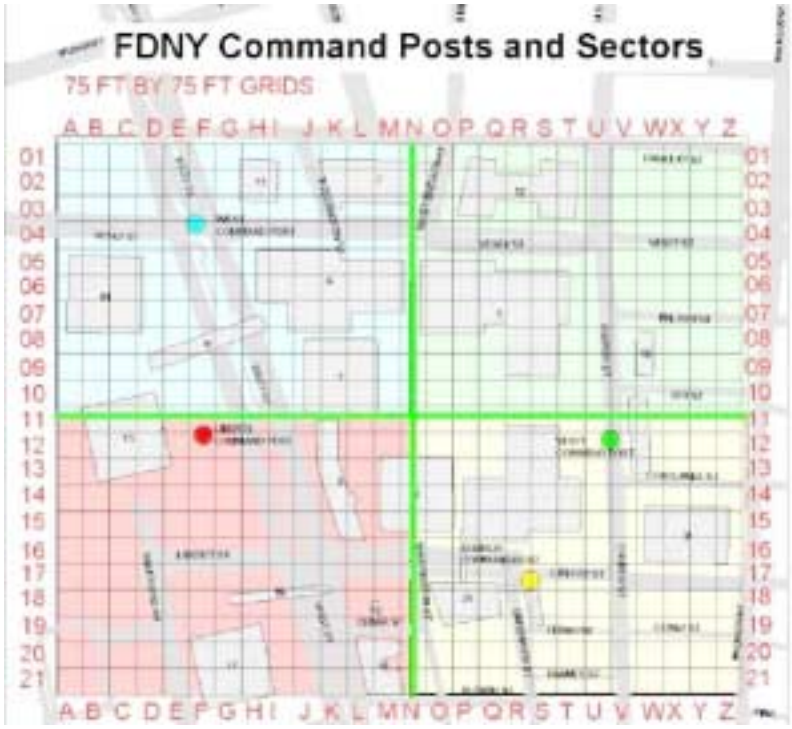

Figure 5. A grid was placed over the entire World Trade Center site to assist coordination and communication.
(Image courtesy FDNY)

8. Victoria's capacity to respond to a large emergency using GIS

Victoria's emergency services have begun the journey to use GIS at emergency events but most of the bigger issues dealing with coordination and integration of systems have not been tackled.

Victorian emergency services with the possible exception of NRE Fire Management have a long way to go in the wide scale implementation and use of GIS. Each has it's own reasons which include access to funds, poor communications bandwidth into rural Victoria or simply a failure to corporately recognize the value of the technology.

There are Government wide issues that at the time of writing remain as barriers to the uptake of GIS. The foremost issue is that of data licensing fees. Victoria's Department of Natural Resources and Environment manages the framework GIS datasets which form the basis for all GIS data information in Victoria, yet the Emergency Services cannot afford to use them fully.

There is no nominated central facility capable of providing the type of geographic information support that was evident in NYC (See Appendix 1 for list of requirements to run a September 11 type response).

As yet there is no systematic plan to bring emergency services into the world of GIS. Each service is left to it's own devices and it's own budgets on it's own I.T. systems. A coordinated response is not possible without coordinated information. This applies directly to the implementation and use of GIS in Victoria.

On the positive side the use of GIS is growing throughout Victoria's Emergency Services. Geoinsight (a Federal Government consultancy tasked with reviewing use of GIS in Australia's Emergency Services) recently reported that "significant progress has been made in Victoria in the adoption and use of spatial information systems."

At a public safety forum in Melbourne, presentations described the use of GIS by Victoria Emergency Services in a variety of applications such as locating fire stations, planning dynamic crowd control measures at public rallies and multi-hazard risk assessment. Other examples of its current use include:

- Dispatching – SI based computer aided dispatching
- Policing - crime pattern analysis using SI to discern trends
- Firefighting - locating firefighting aircraft in real time, bush-fire perimeter mapping
- Ambulance management – Service performance analysis
- Search and rescue - the use of GPS receivers in conjunction with GIS to aid in search and rescue
- Infrastructure planning - planning of new fire stations on Melbourne's expanding metropolitan fringe
- Scenario planning and simulations – planning for natural disasters and epidemic outbreaks

9. Summary and Conclusions

Geographic Information Systems, as used at the Worlds Trade Center, provided a key information support platform during the response and recovery effort. From workers at the site using various hand held equipment to operations managers using aerial photos and images, spatial information was used throughout the operation. GIS personnel became key supporters for emergency managers, supplying many audiences spatially based analyses and information.

Victoria is not ready to adequately respond to a large emergency event in the same way that NYC did.

GIS technology is available in some parts of Government but there is very little exchange of information or integration of systems. Shortcomings exist across the range of areas, including system compatibility, sharing of data, use of standards, access to privately held data sets and communications infrastructure into rural areas.

GIS needs to be recognized as a vital component of emergency management at the highest levels of Victorian emergency management and in Government. It must be supported as a priority.

The life saving potential of Geographic Information Systems decreases as the duration of an event increases. Should an emergency occur in the near future any time wasted now will have to be made up in the frantic hours and days of the aftermath, only the job will be done with one hand tied behind our backs and take weeks longer than if we can get the system ready now.

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11. Appendix 1

Requirements for a GIS support facility

If a GIS and information center was required to support a response to a major emergency what would be required to set one up? This Appendix details some initial sizing and skill set requirements.

Information Products

During major emergencies a number of audiences for spatial information products exist including on-scene workers, Operations management, Government, the public and the media.

The types and styles of information products should be determined beforehand. Templates should be developed reflecting the needs of the identified audiences.

Labor

During a large unforeseen event it will be necessary to draw GIS Labor from a variety of sources including responding agencies, government departments, private companies and academia.
A cadre of GIS professionals should be identified and nominated. Personnel should be accredited to respond into an emergency environment and be competent in the use of nominated technologies

Private local companies should canvassed for their ability to contribute to the management of emergencies by the provision of software and services.

Data and information

Spatial data needs for a major emergency event are extensive. Data should be multi-scale and multi-level. Data used in emergencies must be built from a solid foundation being the state framework datasets.
A repository for all Government data identified as being useful in support of emergencies should be developed.

Custodians of major lifeline datasets should be encouraged to develop accurate and authoritative data. Deep infrastructure/utility data sets such as sewer, cable and pipeline datasets should be available for use. Data such as these should be accessible and compatible with other framework datasets.

Local government will be important suppliers of data and information. Their data holdings should be assessed and registered. Access and incorporation into standard data libraries should be trialled and tested during exercises.

Remotely sensed data

The requirement for remotely sensed data such as aerial photography is high. This will need to be provided on an ongoing basis in a digital, rectified format compatible with standard GIS and Mapping technologies. Standard long term contracts should be put in place for the supply of remotely sensed data.

Research should be conducted into the applicability of drones capturing remotely sensed data, not only imagery but other environmental information.

Skill sets required by the major response facility

Staff management
Database modelling, management and administration
Data reformatting and integration
Web development
Programming in modern languages (VB, C++, Java)
Cartography, map production and printing formats
Remote sensing and analytical skils
GPS theory and implementation
IT support including network management, system security, backup procedures, plotter and printer support, communications including wireless technologies
CAD packages
Scanning and conversion to GIS databases
Use of PDAs, field data capture, form design
Staff trained in emergency management systems such as ICS and have skills in the field pertaining to a range of incident types i.e. medical, biological, fire

Contract management

Software and processes required by major response facility
Permanent standing agreement with software suppliers to supply multiple licenses during emergencies
Map request handling system
Staff management scheduling
Database management system
GIS - multi-functional including analysis, mapping, programmable, Extensions, executables, web deployable
Interactive raster/vector data model
Data Interchange software
Remote sensing software
CAD, Drawing , animation software
Office software
GPS software

Computer requirements in a major facility
PC's, large screen
Network, cables, high speed connections to ISP and other trusted network points
Server computers
Backup facilities
Plotters (Large format)
Printers (high volume laser, high speed inkjet)
Color photocopier (hi-speed)
Large format scanner
Map cabinets, trimming facilities, map viewing tables, laminator
Teleconferencing and data projection facilities

Location of facilities
Should be two permanent sites in Melbourne and two in regional centers; could operate on a day to day basis as normal government offices to be used during emergencies
Options should include flexibility to deploy entire operation to a new site

Major facility should be supplemented with a Mobile GIS capacity supporting on-scene activities; Center would provide mapping and situation reporting rather than analytical processing which would be achieved at central facility; Unit would be attached to planning section at Incident Control Center.
Adapt or supplement a police or fire mobile communications van
Equipment:
GPS, PDA mobile mapping equipment
Paper map production facilities
On site training of operational personnel
Communications links to major facilities
Web/FTP access
Laminator, plotter to use weatherproof paper where appropriate
Server, network, communications
Skill set to include flexible data capture skill sets including deployment of various data capture instruments
Data to be capable of direct ingestion into information system
Access to map templates to enable standard look and feel to map products

Training
Team would require training in exercises alongside operational staff e.g. terrorist, anthrax attack

12. Recommended Reading and websites

R. W. Greene
Confronting Catastrophe: A GIS Handbook
ESRI, 2002

G. Amdahl
Disaster Response: GIS for Public Safety
ESRI, 2002

New York City Office of Emergency Management
www.nyc.gov/html/oem/home.html

New York City Police Department
http://www.nyc.gov/html/nypd

New York Fire Department
http://www.nyc.gov/html/fdny

New York State Office for Technology, Center for Geographic Information, GIS Clearinghouse
http://www.nygis.state.ny.us

US Department of Homeland Security
http://www.whitehouse.gov/deptofhomeland/

US Geological Service
http://geomac.usgs.gov

US Federal Emergency Management Agency
http://www.fema.gov

Environmental Systems Research Institute
http://www.esri.com