Capturing Hurricane Katrina Data for Analysis and Lessons-learned Research

Final Report

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EXECUTIVE SUMMARY

The project team captured information about the role of geospatial technologies during the Hurricane Katrina disaster response from ‘boots-on-the-ground’ experiences, two workshops, and a survey of map users and producers. Important lessons learned from “Capturing Hurricane Katrina Data for Analysis and Lessons-Learned Research” include the need to: develop and maintain centralized geospatial database comprised of locally accurate data, develop and improve geospatial capabilities at local/state/federal levels, identify response culture similarities and differences that require standardized or customized geospatial products, develop input data criteria for analytical models, and develop tools that quickly document damaged areas. While over 80% of response entities indicated that maps were effective for decision makers, over half of map producers said that data availability or data access issues were most often the reason a map product was not available to users in the field. Survey results also revealed how responders’ from a wide array of agencies ranked the importance GIS layers they requested in the aftermath of Katrina. Roads, emergency facilities, supplies, hospitals, and telecommunications coverage were determined to be the five most critical layers. Another key finding of the study was the need for rapid delineation of damage extent and severity on post-disaster high-resolution imagery. Delineation of damaged areas is critical to the safety and effectiveness of responders and recovery personnel operating in the harsh post-disaster environment.

These findings illustrate the need to: identify gaps in high priority GIS data layers; provide a means to assess current geospatial capabilities at local, state, and federal levels; identify the cultural norms of response agencies that can guide the development of standardized GIS/RS products; and identify currently available tools that can delineate damage from space-borne or aerial imagery and disseminate the enhanced imagery products to responders in the first few days following a disaster. Dissemination of data can be greatly improved by providing public access to the extensive and exhaustive archive of raster and vector data collected in fulfillment of the objectives of this project. These data and documentation of project findings are available on the project website at: http://www.katrinalessons.msstate.edu/. A limitation of the archive is that it contains data and PDF sample map products from the Mississippi Gulf communities only. The utility of the site can be significantly enhanced if the geographic scope of the site were to be expanded to include data from other hurricane prone regions in the Southeast. Recommendations for additional research into methods that will enhance the effectiveness of geospatial technologies for disaster management are proposed. Recommendations include development of a mirror data repository at ORNL that includes similar data from other communities and regions in the Gulf and Southeast states, development of a web-based tool for community geospatial readiness assessments, and will provide significant value-added to the current Phase I data archive and development of a questionnaire focusing on response agencies’ cultural norms for the purpose of developing recommendations for standard geospatial output products that serve the greatest number of responder needs.
Introduction

Mississippi State University (MSU) was tasked to assist the Southeast Region Research Initiative (SERRI) Program within the National Security Directorate of Oak Ridge National Laboratory (ORNL) to create a national resource for conducting “lessons-learned” research associated with the application of geospatial information technologies to disaster management in the aftermath of Hurricane Katrina. Key objectives included 1) provision for access to geospatial data and products that were acquired for response and decision making in Mississippi, and 2) to identify the social context under which the technologies were employed during the weeks following landfall of Hurricane Katrina. Knowledge gained through this project assists the Department of Homeland Security by enhancing understanding of the intricacies of the deployment of geospatial information technologies at local, state, and federal levels during natural and human-induced disasters, and in enhancing preparedness for future natural and willful disasters. This resource provides an educational forum for the geospatial community and the emergency management community to learn how geospatial technologies were implemented for the Katrina disaster, and serves as a guide for defining future best-practices for the effective implementation of geospatial information in disaster preparation, response, and recovery.

Scope of Work

During the specified period of performance, a series of tasks were undertaken to develop the national resource for identifying and analyzing the effectiveness of geospatial technologies in the management of the Katrina disaster. Completion of these tasks has resulted in the development of a comprehensive database of GIS layers, remotely sensed
imagery, examples of hundreds of maps produced by local EOCs, and in-depth analysis of social contexts that drove the creation of map products and that illustrate gaps in the effective application of geospatial technologies for disaster management. The project team accomplished the following tasks:

Task 1: A computational infrastructure was designed to manage and distribute Katrina geospatial data and information acquired during the course of the project.

Task 2: Geospatial data and procedures for effective disaster management were compiled and stored on the computing infrastructure.

Task 3: Assessed effectiveness of geospatial methodologies and products implemented for Katrina disaster response.

Task 4: Katrina geospatial data producers and users were surveyed to determine best case solution processes for the implementation of geospatial data for disaster planning and response.

Task 5: The Katrina ‘Lessons’ website was designed as a contextually-based tool for responders and managers worldwide to learn about effective geospatial data and procedures for disaster management.

Task 6: Numerous social, economic and health data were acquired and analyzed for their usefulness in disaster response.

Task 6a: A survey was distributed to post-Katrina first responders and survey results analyzed to assess geospatial product use and production trends during Katrina response.
Methods

*Computing infrastructure development and data compilation (Tasks 1, 2, and 6)*

Task 1 requirements were met through the acquisition of computer hardware and software necessary to catalogue, and manage data and to interactively display data and maps via web requests. The spatially-oriented, enterprise relational database management system is accessible via the internet at http://www.katrinalessons.msstate.edu/Enterprise.htm. The system architecture is illustrated in Figure 1. The 6 server system is based on the Sun Fire X4450 platform with Intel Quadcore CPUs, 16 GB RAM/CPU, over 16 TB of disk space, 10 GB Ethernet network, server failover, data redundancy, and 24/7 managed security.

![Figure 1. Server configuration](image)
Task 2 requirements necessitated the acquisition and storage of geospatial data relevant to Katrina disaster response. The physical and geographic impact of Hurricane Katrina was greater than what anyone had anticipated as enormous amounts of geospatial data were compiled at all decision levels. Local databases (both hard-copy and digital) along the Mississippi Gulf Coast were acquired where available, although some data were lost due to wind and/or surge. Base map data were obtained from nationally-distributed, public geographic databases, such as StreetMap® and the Geographic Name Information System (GNIS) from the U.S. Geological Survey. Prior knowledge of “perceived” data quality of these public databases was sufficient to accept them for the immediate use in developing geospatial applications for search and rescue. The GNIS was also used to define cultural landmarks in the impacted area of southern Mississippi. This database was particularly important in rural areas where first responders were not familiar with the local areas. Examples of landmarks include cemeteries, churches, and schools. The GNIS database is updated as soon as changes occur in the counties and are submitted to the U.S. Geological Survey.

NVision Solutions, Inc. collected Katrina-related data and maps from the geospatial groups of as many organizations as possible involved in the Katrina response. These organizations included the Hancock County Emergency Management Agency, FEMA, the Florida Community Emergency Response Teams, the GIS Corps and the South Mississippi Planning District. These data and maps are available on the Katrina Lessons Learned Project site.(http://www.katrinalessons.msstate.edu/Katrina_PDFs.htm) NVision also collected contact information of local emergency management officials as well as first responders from around the nation. This group was invited to the two
workshops and received web or mail surveys to assist the project team in understanding the geospatial products and production methods that worked after Katrina. NVision facilitated discussions during the conference with state and local responders about data, procedures, and how they were applied after the storm as well as ideas about what might work better.

To satisfy the requirements of Tasks 6 and 6a, social, economic and health data were compiled from numerous sources including the Red Cross National Shelter Database and local jurisdictions. The dynamic nature of these datasets made acquisition of a complete archive extremely difficult. Consequently, PDF map products were compiled based on responders’ requests in Hancock, Harrison, Jackson, George, Pearl River, and Stone counties. A small subset of these PDF products and interactive maps available for viewing on the Katrina ‘Lessons’ website includes:

- Emergency and relief facilities
- Schools
- Law enforcement
- Fire departments
- Hospitals
- EOC’s
- Water and ice distribution locations
- Healthcare facilities
- Wetlands
- Archaeological sites
- Insurance
Website development, information dissemination (Task 3)

To facilitate the dissemination of materials and proposed solutions that were developed during this project, a ‘Katrina Lessons’ website was developed that contains all relevant research materials and recommendations for follow-on research that can further enhance understanding of the effective application of geospatial technologies for disaster management. ([http://www.katrinalessons.msstate.edu/index.html](http://www.katrinalessons.msstate.edu/index.html)) Based on the data compiled in Task 2, the project team has designed the website as an interactive tool to provide researchers access to the compiled data and to provide a learning forum for researchers, decision makers, and responders. All pertinent data and information were organized from the context of ‘lessons-learned’ and all ‘lessons’ supporting documentation, compiled data, and assessment of future challenges for the successful implementation of geospatial technologies are included on the website.

NVision’s role as the map producing entity at the local EOC in Hancock County, considered the epicenter of the storm, was a rich source of information on the development and distribution of geospatial products and tools in the aftermath of Katrina. Their ‘boots-on-the-ground’ view of the disaster offers unique perspectives and information dissemination opportunities that are only available to certain groups that were integral and indispensable to the disaster response effort. NVision performed a case study documenting problems and solutions in the Hancock County EOC including a paper and a presentation titled, “Hancock County EOC Support: Mapping the Hardest-Hit County Post Katrina” available on the project website at [http://www.katrinalessons.msstate.edu/Documents/NVision_GIS_Procedures_Paper.pdf](http://www.katrinalessons.msstate.edu/Documents/NVision_GIS_Procedures_Paper.pdf)
The project site publications page includes additional presentations and documentation by NVision regarding geospatial lessons learned. NVision, along with Mississippi State, has presented and co-presented these findings at multiple emergency management conferences outside of the SERRI project to further promote additional research and broader participation on this topic. The project team also participated in emergency management events including:

- ESRI User Conference
- Directions Magazine Rocket City Geospatial Conference
- Georgia Governor’s Emergency Management Conference
- Maryland Emergency Management Agency 2008 “Ready-Set-Survive” Conference
- Pacific Northwest Asymmetric Warfare Exercise
- Mississippi-Alabama Hurricane Conference
- Mississippi Emergency Management Agency/ Mississippi Civil Defense and Emergency Management Association Conference
- Directions Magazine Location Intelligence Conference
- Mississippi Planning and Development Districts Annual Conference
- Erdas GeoConnect 2008
- ASPRS Annual Conference
- The World Disaster Response Summit

Since Katrina made landfall in 2005, a number of natural disasters have occurred domestically and internationally. An ORNL team led by Chelsea DeCapua investigated lessons-learned in the application of geospatial technologies in response to Katrina,
California wildfires, 9/11, and the Indian Ocean Tsunami. Analyses were carried out using Piranha®, a software that parses large amounts of text data and extracts keywords and themes. Eighteen different search terms were used to collect 106 documents related to topics such as information; communication and geospatial technology during a hurricane. This collection represents a subset of what general data is public knowledge.

To gain a better understanding of the effectiveness of spatial data products developed in the wake of Hurricane Katrina, the “Katrina: Lessons Learned” research team hosted and facilitated a survey development workshop. This workshop was held to initiate a process of gaining perspectives and input of decision makers from federal, state and local agencies as well as first responders. The workshop agenda included a general session followed by breakout sessions combining federal and state participants and sessions combining local agencies and first responders. A second general session completed the day’s activities. General topics discussed centered around how GIS can help (1) person-to-person communication, (2) map-to-person communication and effectiveness, (3) timing in the decision making process and (4) the resiliency of the state of Mississippi in the event of the next natural or willful disaster. The feedback resulting from this workshop served as a guide in developing a survey instrument for polling a larger group of spatial data users involved in the hurricane aftermath. The Social Science Research Center at Mississippi State University implemented the workshop suggestions and ideas in the development of the web-based survey intended to gain a larger number of responses from the community of geospatial data users. The survey was implemented both online and via postal mail. 442 surveys were mailed out and there were 121
requests for online surveys. Online response rate was 38% and mail response rate was 6%.

After data and procedures were evaluated, as outlined in Task 3, project team members in association with ORNL researchers have constantly revisited and attempted to document data and procedures that proved to be successful in delivering requested information products to first responders and similar clientele. Several solutions have been proposed that, if implemented, will result in improvements in obtaining similar and better data, and increases data management efficiency for subsequent disasters.

**Results**

**SYSTEM SPECIFICATIONS**

The spatially-oriented, enterprise relational database management system developed as part of this project is accessible via the internet. The servers and database are currently maintained at the GeoResources Institute (GRI) as part of the High Powered Computer Collaboratory (HPC$^2$) systems network. Currently, a port is open that allows national access to the system for viewing the database including the geospatial products that were compiled during the course of this project. Due to confidentiality restrictions for some data, and general security HPC$^2$ requirements, data are not currently available for downloading offsite. The project team recommends that a mirror site be implanted at ORNL that can monitor access and acquisition of confidential and publicly-available data and serve as a system and data archive. The current implementation of the website and database portal provides viewing access to actual GIS and RS data via the implementation of an ESRI-based ArcGIS ‘Server’. GIS and RS layers can be selected, viewed, and layer attributes queried.
LESSONS

Lesson Learned:

Successful implementation of geospatial solutions for disaster management was greatly hampered by dispersed and inaccessible data.

While over 80% of response entities indicated that maps were effective for decision makers, survey results indicated that over half of map producers surveyed believe that data availability or data access issues were most often the reason a map product was not available to users in the field (Figure 2). The recurring theme of dispersed and inaccessible data is documented in the project team’s ‘Survey Development Workshop’ report (Appendix 1), in the project team’s technical report: ‘Lessons Learned from a Social Perspective’ (Appendix 2), in the project team’s assessment of the role of geospatial technologies for international disasters (Appendix 3), and from ‘boots-on-the-ground’ experiences at local EOC’s. These findings illustrate the need to identify gaps in high priority GIS data layers and provide a means to assess current geospatial ‘readiness’ at local, state, and federal levels. Assessing the state of geospatial readiness is an essential first step to illustrate data gaps in a format that is appropriate for decision processes that are oriented towards prioritizing data and infrastructure improvements. Concurrent with eliminating data gaps is the need to develop and maintain a centralized database management system that facilitates data access for decision makers, geospatial analysts, and responders at multiple decision levels.
Figure 2. Ranking of importance for critical data layers to emergency responders (survey results).

The project survey results also reveal that about 50% of map users and producers believe that conditions are better for map production now than they were in the aftermath of Katrina. Upstream improvements in data acquisition, quality, and availability has led to improvements in the number of GIS-ready layers that support future disaster management. Examples include continued development of Homeland Security Infrastructure Program (HSIP) ‘Gold’ and initiation of HSIP ‘Freedom’ for national and state disaster management clients, and implementation of Project Homeland in Mississippi that provides input data for the HSIP ‘Freedom’ database. HSIP freedom data directly benefits multi-level jurisdictional disaster management efforts, especially when geospatial technologies are a part of disaster management plans. Mississippi has made modifications to RS data acquisition specifications that provide inclusion of the Near Infrared (NIR) wavelengths (band) for future National Agriculture Imagery.
Program (NAIP) imagery purchases. In Mississippi, NAIP natural color imagery provided most of the baseline imagery used for assessment of pre-disaster conditions. The inclusion of the NIR band will greatly enhance image processing opportunities for disaster analysis products in Mississippi, particularly for delineating damage to vegetation, and for mapping flood inundation. Currently, each state determines whether the NIR band is worth the extra cost for the acquisition of NAIP imagery that includes the NIR band. The USDA Farm Service Agency (FSA) is currently looking for state agency partners to help fund this year's program. Desired contribution from state agencies is one third of total cost for the natural color band acquisitions; however the ‘up-charge’ for the NIR band can be as much as an additional 33% of the total cost.

Workshop and survey results indicate clear preferences for critical GIS layers needed for disaster management (Figure 2). The survey of map users and producers revealed that roads, emergency facilities, supplies, hospitals, and telecommunications are the five most critical layers. Local road maps were the most often requested cartographic product from the GIS support facilities in the Emergency Operation Centers and were listed as the most critical layer in the survey results. Most of the first responders working in the Coastal Counties originated from Mississippi counties and states outside the impacted area. Readily available georeferenced road network databases combined with other critical layers enabled the production of thousands of maps. Road networks were available from the U.S. Census Bureau’s TIGER files and from the sample data disk provided by ESRI that contained StreetMap® coverage for the United States. Nevertheless, local streets were not always up-to-date in these databases. For example, in September of 2005, the 2004 version of StreetMap® was available. The road networks
for southern Mississippi were primarily extracted from the 2004 2nd edition of the TIGER line files for use in making maps at the Hancock County EOC. Maps of temporary supply distribution locations were delineated through informal correspondence with the administrative staff of the local Emergency Operations Centers. Due to the emergency conditions of the days and weeks immediately following the hurricane, as well as the ephemeral nature of distribution sites, detailed record management of correspondence was not maintained for this extremely dynamic information.

The ‘patchwork’ of image acquisition specifications and the inconsistent maintenance of spatially and temporally accurate ‘critical’ layers at local jurisdictions across the southeast, indicates that significant gaps still exist in critical data necessary for effective regional disaster management. Although HSIP ‘Gold’ and HSIP ‘Freedom’ are extremely valuable data, the availability and maintenance of locally-accurate and temporally-current data at local jurisdictional levels remains a challenge. Ultimately, all disasters occur locally and while locally-accurate data can be easily aggregated for state, regional, and national mapping and analysis needs, the reverse (dis-aggregation) is not generally possible. Consequently, tools need to be developed that illustrate communities’ ‘Geospatial Readiness’ that can guide effective allocation and prioritization of resources necessary to eliminate data ‘gaps’.

Although an extensive archive of raster and vector data (13 Terabytes) were collected in fulfillment of the objectives of this project, these data were compiled from numerous sources and are of widely variable quality. The acquisition, data quality control, and distribution of geospatial data for future disasters requires an assessment of the gaps in locally accurate data that still exist and an assessment of the limitations to
providing rapid access of these data to the public. The archive contains data and PDF sample map products from the Mississippi Gulf communities only. The utility of the site can be significantly enhanced if the geographic scope of the site were to be expanded to include data from other hurricane prone regions in the Southeast. The enterprise data system that was developed and is maintained at the HPC$^2$ at MSU does not contain some confidential and restricted access data that are available at ORNL. Another limitation to providing access to data maintained at HPC$^2$ is the lack of full-time data and systems administration personnel necessary for continually updating the data, and monitoring and serving high numbers of data download requests.

Even when high-quality pre-disaster imagery is available for a disaster location, as previously discussed, dissemination of data can be greatly hampered by the lack of a centralized repository and server system that enables rapid public access to the data. All levels of government must be made aware of the capacity GIS has for emergency response. The development of a mirror data repository at ORNL that also includes similar data from other communities and regions in the Gulf and Southeast states would provide significant value-added to the current data archive and geospatial server environment. Architecture developed for a mirrored site should be flexible enough to pass required inputs to all distributed geospatial models identified as useful for disaster preparedness and response activities; or if the model requires high performance computing capabilities, the ability to launch the application to that platform from within the geospatial server. Identification of input layers for geospatial models will also be a significant step in correctly defining the list of critical layers that are recommended for geospatial ‘readiness’.
Challenge 1:

To increase awareness of local, state, and federal decision makers of the need to maintain locally-accurate, high-priority GIS layers that will enhance effective implementation of geospatial technologies for disaster management.

Recommendation 1:

The project team proposes the development of a web-based Geospatial Readiness Self Assessment Tool that enables communities to assess their geospatial vulnerability with respect to the status of the high-priority GIS data layers identified during this project.

Challenge 2:

To maintain, update, archive, and distribute these, as well as other confidential GIS/RS data sets (e.g. HSIP GOLD) maintained at ORNL that were acquired during the course of this project.

Recommendation 2:

The project team proposes the implementation of a mirror data repository at ORNL with the goal being to develop a feasibility plan for scaling it to a SERRI archive with similar data from other communities and regions in the Gulf and Southeast states.

Challenge 3:

To determine the appropriate input data for a variety of damage estimation and simulation models; both existing and current under development for SERRI projects.

Recommendation 3:

The project team proposes a review and analysis of existing and geospatial analytical tools under development that are appropriate for various phases of emergency
preparedness, response and recovery, focused on identification of appropriate required
input data for these tools.

Lesson Learned:
Knowledge of responder cultures is a critical element for defining standardized and
customized geospatial products that aid effective disaster management.

Identification and documentation of the cultural norms of response agencies and
assessment of geospatial tools and products necessary for the development of
standardized and customized GIS/RS products is a critical need. Geospatial technologies
are powerful and good GIS analysts are adept at quickly producing a variety of custom
and standardized products that can meet a variety of response cultures’ needs.

Workshop and survey results from this project revealed that, for the Hurricane
Katrina response, an equal proportion of customized and standardized geospatial products
were requested. Geospatial technologies are powerful tools for the creation of both
standardized and customized products, but meeting response cultures needs requires
understanding responders’ needs and making responders aware of the variety of
‘standard’ products that are available or easily produced. While the project ‘survey’
captured opinions, beliefs, and experiences of response agencies that used geospatial data
during the aftermath of Hurricane Katrina, the anonymous nature of the survey precluded
identification of specific response culture needs. Additional information is needed to
gain insight into the practices, opinions, or beliefs of multiple emergency response and
recovery cultures.
Although the exact number of users and producers of geospatial data after Katrina is unknown, the resulting number of user responses (n = 44) and producer responses (n = 16) to the survey was considered acceptable by the project team to draw general conclusions. Likewise, it is impossible to know if the sample of survey respondents constitutes a representative sample of either of these two groups, but the consensus of the project team indicates there is a confidence in the number of participants and the findings resulting from the survey.

The survey focused on (1) person-to-person communication, (2) product delivery and timing issues, (3) map effectiveness in the decision making process, and (4) preparedness and resiliency estimation. From the survey results, the project team identified some major findings that clearly illustrate trends and the need for further research into the area of geospatial product use in disaster response and recovery efforts. The first of these finding was that maps are universally considered to be an effective tool by users in the field. Almost 80% of map user respondents stated that maps were very effective or somewhat effective in the decision-making process. A second finding is the identification of five critical data layers for inclusion on map products. Survey results show that both user and producer respondents feel that roads, emergency services, supplies (food, water, ice), hospitals and telecommunications were the most critical layers for most map products during response and recovery efforts. The third major finding was with regard to data access issues. From the survey responses, more than 50% of map producer respondents stated that data availability or data access issues were very often or often the reason preventing the production of a map product intend for users in the field. A fourth finding is the common belief that standardization of map products was a highly
desirable benefit to disaster response and recovery activities. The prevalent opinion among map users was that there should be equal production of both standardized and customized map products, while producers tend to believe that a more standardized approach may yield more beneficial results. The fifth and last major finding was the overall belief that local EOCs outperformed other agencies in their geospatial response to the needs brought about by the storm. The survey results also proved to be an invaluable tool for the project team to understand the needs of users and producers as they worked towards the development of a functioning map-viewer web portal.

Following completion of the survey dissemination and information gathering, the project team hosted a 1-day end-of-project workshop at GRI on June 25, 2008. Our guest professionals applauded our research efforts and concluded by encouraging the research team to present three to five top research findings to the Mississippi Coordinating Council for Remote Sensing and Geographic Information Systems (more commonly referred to as the MS GIS Council). This was stated with the hopes that the council would place emphasis on the research results and continue to recognize emergency response issues as a top priority in the State of Mississippi.

This research effort uncovered many other interesting results that can be found on the Katrina Lessons website at www.katrinalessons.msstate.edu. However, it should be noted that there is a need for more in-depth questioning of geospatial product users in response and recovery efforts. A better understanding of each culture’s standard operating procedures and their beliefs, opinions, and practices with regard to cartography, symbolism and characteristics for overall map effectiveness would be most beneficial to those who produce geospatial products.
**Challenge:**

*To identify and document the cultural norms of response agencies and develop a set of recommendations for geospatial tools and products essential for the development of standardized and customized GIS/RS products.*

**Recommendation:**

The project team proposes the development and implementation of a questionnaire focusing on cultural norms and practices of emergency response agencies for the purpose of determining the needs and developing recommendations for standard geospatial output products that serve the greatest number of responder needs.

**Lesson Learned:**

*Rapid delineation of damage severity and extent on post-disaster RS imagery is critical for effective disaster management.*

A critical need expressed during Workshop 1 was rapid delineation of damage extent and severity on post-disaster high-resolution imagery. This damage delineation is critical to the safety and effectiveness of responders and recovery personnel operating in the extremely harsh post-disaster environment. The need to delineate damage on high-resolution imagery was clearly demonstrated in the areas that were hardest hit by the hurricane due to the destruction of street signs and other navigation landmarks. A routinely requested product at the Hancock County EOC was post-disaster high-resolution imagery overlaid with GIS road layers. A related need was a system for rapidly updating imagery for the dynamic field conditions. An ideal system for effective use of pre- and post-disaster RS imagery would include: 1) rapid change detection methods that
enable damage delineation from RS data within a few hours of an event; 2) automated rectification and mosaicking of imagery enabling ‘correctly’ placed road networks and other critical data layers; and 3) a method for assimilating field information and rapidly updating image-based ‘damage’ products. There are a number of tools and methodologies that can help with the development of the ‘ideal’ system. Currently, the SERRI program is funding several projects that are focused on the development of methodologies and tools that can delineate damage from space-borne or aerial imagery and rapidly disseminate the enhanced imagery products to responders in the first days following a disaster. ORNL’s rapid damage delineation tool developed for this project is illustrated in Figure 3. Delineation of damage on aerial and/or satellite imagery requires pre-disaster and post-disaster imagery. As previously mentioned the Farm Service Agencies’ NAIP imagery products are an available pre-disaster product in most states, but often minus the NIR band that is critical for assessing damage to vegetation and mapping flood extents.

Currently, existing geospatial tools and tools under development that are appropriate for various phases of emergency preparedness, response and recovery have varying input data requirements. Analysis on the inputs necessary to implement the wide variety of geospatial tools being developed under the SERRI umbrella is needed. Tools such as the debris delineation tool developed at ORNL, UM-proposed methods for damage delineation, and debris type and volume estimation tools identified in the Tools for Enhanced Mapping and Managing Post Disaster Debris project should be evaluated per data input specifications. Analyzing data inputs necessary to drive these models can provide valuable information regarding the acquisition and centralized maintenance of data, and further enhance tools designed to assess geospatial readiness.
Challenge:

To rapidly delineate damage severity and extent, and to quickly distribute the products to response and recovery personnel operating in harsh post-disaster environments

Recommendation:

The project team proposes development of recommendations for a system that makes effective use of pre- and post-disaster RS imagery for rapid response products including:

1) identification of geospatial input data that are required to implement tools, both existing and under development, for delineating damage extent and severity
2) automated co-registration and mosaicking of imagery;
3) overlaying of road networks and other critical data layers on the response products; and
4) development of methods for dynamic updating of response products.
Conclusions

Important lessons learned for effective application of geospatial tools to disaster management include:

1. Successful implementation of geospatial solutions for disaster management was greatly hampered by dispersed and inaccessible data;
2. Knowledge of responder cultures is a critical element for defining standardized and customized geospatial products that aid effective disaster management;
3. Identification of input data necessary for GIS-based analytical models will enhance the implementation of those models for effective disaster management;
4. Rapid delineation of damage severity and extent on post-disaster RS imagery, and rapid distribution of products to recovery and response personnel operating in harsh post-disaster environments, enhances personnel safety and disaster management effectiveness.

The research team recognizes that several challenges exist in applying the lessons learned to affect substantive change necessary for improving the effectiveness of geospatial technologies for future disaster management. Progress has been made in locating, storing, and cataloguing data and procedures implemented for Katrina disaster management. Progress has also been made in developing methods for incorporating local information and data into centralized data archives (e.g. HSIP ‘Freedom’). Nevertheless, there is much left to do to enhance preparedness. Fully-populated databases of locally-accurate data are not yet a reality, nor are viable alternatives for communication and distribution of these data clearly documented in GIS preparedness plans at all decision
levels. Numerous challenges exist that must be addressed before successful implementation of a centralized database for disaster management can become a reality. Challenges include 1) development mechanism for prioritizing at-risk communities and for empowering local jurisdictions in the acquisition, updating, and archiving of GIS-formatted data; 2) development of a set of ‘standard’ products that serve the greatest number of response culture needs; 3) identification of geospatial input data that are required to implement tools, both existing and under development, for delineating damage and for simulation purposes; and 4) incorporate existing lessons learned into preparedness plans.
Appendix 1.

Survey Development Workshop Report
Survey Development Workshop for the Southeast Regional Research Initiative (SERRI) Project: Capturing Hurricane Katrina Data for Analysis and Lessons-Learned Research Project

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INTRODUCTION

Disaster preparation, response, and recovery methods require the coordination of federal, state, and local agencies to effectively and efficiently cope with both natural and willful disasters. The utilization of Geographic Information Systems (GIS) allows individuals at each agency level to visualize disasters and coordinate their responses accordingly. However, as in the case of relief efforts after Hurricane Katrina, the inconsistencies in data collection, reporting, and dissemination coupled with mixed metadata development translate into disrupted and/or unusable data visualizations and information exchange to first responders and emergency agencies.
To gain a better understanding of the effectiveness of spatial data products developed in the wake of Hurricane Katrina, the “Katrina: Lessons Learned” research team hosted and facilitated a survey development workshop. This workshop was proposed to gain the perspectives and input of decision makers from federal, state and local agencies as well as first responders. The feedback resulting from this workshop was intended to serve as a guide in developing a survey instrument for polling a larger group of spatial data users involved in the hurricane aftermath.

Unfortunately, the targeted participation of “users of spatial product information for decision making” was not realized, and a majority of the contributions were from the perspective of the spatial product producers. In fact the only first responder participants who were present for the morning general session departed before any of the breakout sessions began. Nevertheless, the sessions were conducted and information was gathered.

For the breakout sessions, the group was split into (1) federal and state agencies and (2) local and first responder agencies. Each group met in separate rooms and given the same set of guideline questions for discussion. The concentrations for the morning breakout session were (1) human-to-human communication and (2) timing issues and product delivery. The focus topics of the afternoon breakout session were (3) map-to-human effectiveness and (4) preparedness and resiliency. This report contains the ideas, perspectives and beliefs captured in the breakout sessions as well as a summation of the written feedback from participants.
GENERAL SESSION
GENERAL SESSION

Dr. David Shaw, Project Principal Investigator and Director of the GeoResources Institute (GRI) at Mississippi State University, provided a welcome and asked each participant to introduce themselves to all others at the workshop. Afterwards, Dr. Shaw gave a quick overview of the Capturing Hurricane Katrina Data for Analysis and Lessons-Learned Research Project. He announced the Mississippi Department of Information Technology Services (ITS) is provisioning a GIS data delivery system based on the Mississippi Coordinating Council for Remote Sensing and GIS plan.

Dr. Buhendra Bhaduri, Research Leader of the Geographic Information Science and Technology Group at Oak Ridge National Laboratory (ORNL), highlighted the work of Chelsea Tecapua, Research Intern at ORNL. Ms. Tecapua’s research of all publicly available documents worldwide resulted in only four documents that mentioned geospatial technology. Dr. Bhaduri continued by indicating a need to tie local level information to federal level information. He stated that local map users need legitimate and reliable information that is appropriate for their purposes. Similarly, the national decision makers need information from spatial products that is credible. We must capture the information of who made the decision to make a particular spatial product and why?

Mr. Joel Lawhead, Program Manager and Web Application Developer for NVision Solutions, Inc., acknowledged that NVision had begun establishing a “GIS Best Practices” for maps and geospatial analysis. Asymmetric warfare exercises illustrated that well-conceived maps can bridge gaps between (1) response agencies, (2) first responders and other decision makers, and (2) levels of decision making. Mr. Lawhead also pointed out that quick map productions (immediately post-disaster) and rapid updating are critical components to successful geospatial solutions in the wake of a disaster. Joel finished his opening session remarks by stating that NVision identified twenty basic map layers that were most common based on post-Katrina needs.

Mr. David Parrish, Senior Research Associate for the Social Science Research Center (SSRC) at Mississippi State University, declared the primary focus of the workshop was
to discuss the ideas and experiences of individuals with respect to the production and use of spatial products in the aftermath of Hurricane Katrina. The intent of these discussions was to aid in the development of a web-based survey on how GIS can help (1) human-to-human communication, (2) map-to-human communication, (3) timing in the decision making process and (4) the resiliency of the state of Mississippi in the event of the next natural or willful disaster.
BREAKOUT SESSION #1
Breakout Session #1: Federal and State Human-to-Human Communication, Timing Issues and Product Delivery

For the most part, users of spatial data understand that there are map tools available but really don’t recognize what these various types of data maps can do for them. Part of the reason for this lack of awareness is the communication gap between the two separate cultures:

1. data users (first responders at all levels)
2. data producers (tech folks).

It was mentioned that a future role of a GIS manager in a disaster situation could be to bridge these disparate groups of individuals (and agencies) for efficiency. A GIS manager could perhaps turn decision-maker needs into a product that fits those needs. It is unfortunate that most of the communicated needs were lost in translation, however, on a positive note, it was stated that the responders from the Mississippi Department of Environmental Quality did know the questions to ask GIS personnel in order to facilitate map production. There needs to be a template that works for the federal folks all the way down the ladder: a nomenclature and ontology that could be adopted by all agencies.

Another major communication disparity involved the levels of government. County, municipal, state, and federal individuals and agencies as a whole did not correspond with one another in a productive sense. The state agencies could not get information to flow in reverse from the federal government. Data restrictions were relaxed for a period but the need was still there when regulations tightened and data access was denied. Similarly, there was too much of a “big brother attitude” from the locals that did not permit data being divulged for the public good.

The issue of delivering maps or data was discussed and most agreed that a physical or electronic map was more suitable than being sent data to be processed on the receiving end. Consequently, it is the main goal of the GIS arm of an EOC to create custom maps for specific purposes in the effort to respond and recover.
In the aftermath of the disaster, a majority of the responders could not orient themselves and navigate. Therefore, the most requested map types displayed roads and functioning cell phone tower locations. The EOC received calls for military and out-of-state police stating they had “tom-toms” and were located at a certain lat/lon. They wanted verification (from aerial imagery) about what they were supposed to be seeing at their particular location. A positive from the data production perspective was that starting points on the maps were known because of coast guard verification in helicopters.

Many references were made concerning the idea that data integrations should be performed before a disaster happens. Parcel data was a highly sought commodity in the wake of the storm and none could be provided. These parcel data should be accompanied by the type of property (industrial park, strip mall, residential, etc.) and how many people should be expected in a dwelling on that property. This information could perhaps be derived from tax assessor data if it were available. Also, 911 records could be pulled in to help verify or complete these tasks. There was also an accord among the attendees concerning the adoption of a common format for operating data.

Discussions about the data to include on a map were encapsulated in two terms: everybody and everything. Although, it was mentioned that maps should not be overloaded with too much information that doesn’t serve a need. The participants agreed that a map tool could be implemented that could address 70 percent of the need in a response effort of a disaster situation. Everyone also agreed that response phase map quality can be less than recovery phase map quality. GIS folks will tend to put more than the needed information on maps and some will try to make the maps aesthetic more so than functional. Simplicity is a key issue to remember.

Some particularly important themes were pointed out:

1. Special needs populations
2. Shelters
3. Distribution points (food, water, ice, etc.)
As stated earlier, there was a lot of controversy surrounding sources and access to data. Should a decision-maker use the first data available or search for more credible data? Responder’s use of GIS services such as Google maps and Mapquest proved to a valuable and identical reference source for communication. Lines of communication were damaged in such a way that packages of maps were shipped out by helicopter from Jackson to the Gulf Coast and hard drives were transported from universities to the EOCs by automobiles. Communication other than face to face could not be conducted with any degree of predictability. Temporary passwords and other limits to access was also a topic of conversation.

It turns out that lack of raster data is not a problem. In fact, the problem was too much raster data! Vendors wanted to give an abundance of data. However, the post-processing of this data would take too much time for its worth. There should be teleconferences to identify flight patterns for aerial imagery.

Reporting and updates were also a major problem. Responders visited the same property again and again because there was no reporting channel. This begs the question, how are any data changes put back into a common system? How do you collect real time data and give to people on the ground? Can you empower the public to add content? It would start with the infrastructure to support the collections. Then there would be the problem of too much data coming in and people working on getting it in versus helping out in the field. Also there would be much data to verify.

Data request priorities were not standardized for focus and efficiency. Data providers agreed that priorities should be placed on map productions. Requests should meet a set of criteria before production begins. Otherwise, time is wasted. Also, tangents from previously made maps can consume an abundance of time with no intended purpose. However, maps were displayed outside EOCs so others could see them and imagine how to use these maps constructively.
FEMA protocol is to find the state lead for geospatial. Often this person is not the one with the answers. GIS personnel and locals can answer questions more accurately.

The change over from the Magic Bus to the JFO took place and it was two weeks before FEMA GIS person was known to be on hand. There were plotters and paper on pallets that were not being used.
Breakout Session #1: Local Agencies and First Responders
Human-to-Human Communication, Timing Issues and Product Delivery

Timing and availability of imagery and data access dominated the majority of the beginning stages of the early morning session. Some of the most perplexing issues the data producers face included 1) availability of accurate data needed to provide accurate products, 2) accessibility to various levels of data in response efforts, and 3) sheer size of data available for use at the time. The timing of the data delivery was not consistent with the needs of the individuals requesting the information. This inaccuracy was further complicated when the provided data proved to be inaccurate with the existing data on hand. This breakdown in accuracy versus timing proved to be a daunting hurdle for the map producers in attendance at the workshop.

Accessibility to the data available also proved to be a large hurdle for those wishing to produce spatial products for the response efforts. Imagery proved to be the most complete information available, but was inaccessible to those who needed the product the most. NOAA flew their planes to collect imagery at the end of August, but the providers were forced to purchase the aerial imagery from Image America due to the inability to contract the NOAA Imagery. In addition to this complication, there were large barriers noted in the needs and collection of the various data between the federal/state agencies and the providers in the field. Many felt the various levels of bureaucracy hindered the immediate response efforts made by those in the field. The result in this delay resulted in an over-abundance of post-event imagery without follow-up imagery for comparison purposes.

The last issue discussed in the early stages of the session was the size of the data provided. Many of the local providers received upwards of 12 gigabytes of data with no real means of processing the data. Many of the local producers were faced with the task of disseminating data without adequate means of processing the available information. As was noted, there were hundreds of computers donated to Mississippi for the response efforts, yet none were able to locate the provided computers in order to use their
computing power. Instead, many were faced with the task of processing this information with the limited processing capabilities previously on-hand.

In addition to these topics, inter-agency cooperation became a heavily contested topic of discussion. Many felt that there was little to no cooperation between FEMA/MEMA and those that were on the ground. These discrepancies came in the shape of incompatible standards, ineffective liaison interactions, and assistance by the participating government agencies. Some noted that when FEMA attempted to be helpful, they were unable to contribute any type of useful information whether through data or spatial products. There was also some discussion about the availability and access to the utility companies’ data and information due to sensitivity issues. Because of the sensitivity of some utility data, the utility companies were unable or unwilling to share the available data with the first responders. These complications proved to be a perplexing hurdle for producers to overcome when trying to provide the most basic information to those on the ground.

Some of the more pertinent issues posed from the group included:

- Timely imagery delivery
- Federal data distribution policies
- Lack of disaster map standards
- Formalization of GIS in ICS
- Inclusion of utility data (namely telephone and electric power)
- Parcel data and street attributed centerline
- Flow of computing resources coming into the State

These topics dominated the majority of the session as a whole. This list was created to give the workshop participants a cooperative understanding of the issues faced across local agencies during this response effort. The producers noted that these were key issues in Katrina’s evaluation process concerning the effective delivery of spatial products in the event of future disasters.

Perhaps the most interesting notion presented in the workshop session was the lack of prior spatial product knowledge before the disaster response. Individuals’ lack of
knowledge pertaining to the various types of information available created an extra layer of communication issues. Also, because the available information was provided online, many did not know where to turn when the connectivity was lost. When faced with questions of where to get the information, producers were forced with the task of directing individuals to available information on the ground. Without the necessary methods of obtaining the online information, producers attempted to inform the responders of the different products that were readily available. Because of the limited working knowledge of the various types of spatial products, this disconnect created barriers to effective communications and response efforts.

Given the expansive needs of spatial products during response and recovery efforts, it may be impossible to overcome certain aspects of these disconnects in the communication efforts. However, addressing issues of timely availability, set policy guidelines, and a formalized method of production and dissemination may provide the proper framework for effective communication between humans in the field and those determining the policies in which to operate in future disaster events.
BREAKOUT SESSION #2
Breakout Session #2: Federal and State Map-to-Human Effectiveness, Preparedness and Resiliency

Maps are intended to take the place of a person telling a story. Reading these stories (maps) always leads to the potential development of parallel or tangent stories. The “wouldn’t this be better if …” or “wouldn’t it be great if …” type of questions are ongoing in disaster situations. Some of these suggestions for additional spatial products are warranted and add value to the response and recovery efforts. Other suggestions tend to deviate focus and would be better suited to post-recovery research efforts. One approach to continuing quality productions while reducing excessive modifications is to develop a “standard but flexible” design or template for about 20 kinds of spatial products. These standards could be the basis for map productions in the next disaster situation and hence evolve during any newly encountered situations.

A few of the map/data requests mentioned in the workshop:

- Blue roof maps with a wind map overlay to validate damages
- Identification of places to put debris
- Demographics
- Enhanced imagery to detect whether homes are in good condition or bad
- Reports on ranges of numbers rather than absolutes (fatalities, evacuees, etc.)
- Locations of food, water, ice supplies and distribution points (very critical)
- Where do people live and where do they work? Will they be available during a disaster or will they be with their family?
- People databases
- Physical infrastructure
- Topography
- Local 911 data

One critical component of effective disaster management is a rapid characterization of the extent of disaster pre-and post-Katrina. Updating maps with temporal changes is also an essential component of spatial product production in a disaster situation. The map users community take the stance of “keep ‘em coming” when referring to the frequency and availability of map products. The map producing community questions for instance,
“Why do I need to update a power map twice a day?” or “How often is change detection needed for forests?”

Assigning priorities to map productions based on a map request form is an interesting topic. A map user could indicate a “use” for the map and the time of production will be dependent upon a previously designed queuing system. Naturally the request form will evolve over time as technologies and situations dictate change. When asked about the value of GIS in an emergency response and recovery effort, a response was “the true value of GIS will be realized when you can say “x” number of lives or millions of dollars are saved by using the technology.”

During the response and recovery efforts, GIS emergency personnel and/or volunteers were derived from the social capital that was already in the geospatial community. Many believe not only the people, but also the equipment, were put together hastily and unsystematically. For instance, GIS operations moved from using ArcView® 3.3 to using ArcGIS® 9.0 in the middle of the aftermath. This was apparently a misguided decision and surely disruptive. Furthermore, even though it took a week to get volunteers to the EOC, some volunteers had to be turned away because of lack of mapping experience. They wanted to learn, but there is very little room for teaching and tutoring GIS in a disorganized setting. Sleep and downtime is actually a much better way to allocate time. The fact plainly is GIS personnel in an EOC must be of sufficient knowledge and flexibility to adapt to changing roles. A disaster situation definitely requires hasty action; however, planning for a disaster can perhaps establishes a systematic and pragmatic order to a chaotic state of affairs.

Also during Katrina’s aftermath, spatial product users in the field were in many ways at the mercy of technology in their correspondence. Some field personnel brought GPS units and wished to know latitude and longitude readings. Other relied on jagged cell phone communication to navigate. Of course the EOC accommodated each request accordingly. However, in retrospect some have indicated a feature that would enhance emergency operations in the future – the implementation of a digital viewing system for
first responders in the field. This system may be possible in the future, but it must be a common system known to all. First responders have also specified that they should only be trained in the systems they will actually use in the field. The use of Blackberrys for the end user is not a widespread, catch-all solution yet.

A related issue was, “How can first responders passively collect data and transfer it back to the EOC?” Of course actively collecting data would not be a justifiable activity compared to trying to save lives. The solution would have to be a system where the collection and transmission of the information is completely transparent to the first responder.

In terms of overall spatial product effectiveness, perhaps the best measure would be a measure of progress – a measure of successes. Sadly, this is a measure that is not currently built into a disaster response and recovery system. Maps tend to fail quietly. Perhaps taking the time to provide feedback would inhibit other activities that are deemed more beneficial and urgent. Nevertheless, a metric of success should not be the number of spatial products produced.

The resiliency of the Mississippi Gulf Coast is apparent and can be attributed to the hand-to-hand cooperation of all those involved in response and recovery efforts. The question that will be continually asked is “Are we more resilient now than we were before Katrina?” It was noted that MEMA has plans in place so Mississippi is better prepared for the next disaster. MEMA had one GIS person before Katrina and now has about eight, and the staff increased from 60 or so persons to about 170. The consensus among the federal and state workshop attendees is everybody is more connected now, and although a new disaster would perhaps be just as chaotic, at least the newly developed connections would serve and benefit the emergency responses of the state.
Breakout Session #2: Local Agencies and First Responders  
Map-to-Human Effectiveness, Preparedness and Resiliency

The primary purpose of maps is to inform individuals of an ongoing event, similar to one telling a story. Discussions surrounding these maps tend to focus on the “what ifs” and “what about this” sentiments. While these can be useful in creating a framework for products, often it is necessary to take into account the practical usefulness of map products when determining an ultimate product. These recommendations in conjunction with recovery research efforts can be utilized to create a standard of spatial products.

Early discussions focused on the different elements needed in the spatial product to create an effective means of recovery response efforts. Many producers felt that in order to have effective spatial products, certain aspects, or layers, were needed to create a useful product capable of being utilized in the field. The group classified these aspects into a listing of the most important spatial data layers.

The list included:

- Population density
- Structure type
- Transportation infrastructure
- Parcels
- Streets
- Post event imagery
- Flood zones
- Updated “standard” topographical maps

Perhaps the most notable comment of the session came during the middle stages of the session. One producer stated, “Are we better prepared now than we were then?” To this, another responded, “We are now aware of what we don’t know”. This is of particular interest to research efforts in the area. There are an abundance of resources available, yet access and information need to utilize these resources is not readily available. There seems to be too much data driven development without enough emphasis placed on application-data development efforts. Individuals do not feel that the availability of
accessible information is a capability of current response and recovery operations. One additional note concerns the accuracy of available information. If there are to be standardized elements of spatial product development, it is essential that the data be accurate and consistent. Population data was one of the areas of noted concern due to its inaccuracy and lack of reasonable population estimates.

Some of the additional requests presented the producers with a unique set of opportunities and feedback segments regarding needs. One noted request was the location of all heads of houses to gauge salmonella outbreak potential. Other requests came from state government agencies requesting power outage and water availability maps. These unique requests present a varied look into the needs of different individuals serving varying purposes in their collective response and recovery efforts.

Politics also played a large role in the production and dissemination efforts. One producer noted that he/she received a request for a power outage map by a government agency. The responder reported being informed that the map was needed to promote encouraging response efforts. Others reported that the products being disseminated deteriorated into political media bait and lost its usefulness. While this type of response is important, it should also be noted that it was not uniformly agreed upon and could represent only a small fraction of the overall response effort. In addition to the political influence, state agencies also posed as hurdles to the individual producers. There was no apparent format as defined by the state mandates. This lack of format was unanimously agreed upon as one of the biggest hurdle to overcome concerning effective delivery of the spatial products.

Concerning all of the useful spatial products available and disseminated, the most sought after and ultimately important products utilized during the efforts were common street maps. Most producers recalled a large amount of street map requests coming from all areas of first response efforts. The one element lacking in this product was simply updates to the available street level information. Most were distributing street maps using 1990 Census-level TIGER files with the street locations. Unfortunately, this
information is largely out of date and produced several basic street maps that were virtually ineffective for first responders. The basic street maps also proved difficult when dealing with extended street signs. Issues where a Main St. sign became Main St. extended were given as examples of standardization issues when dealing with basic street maps without up to date information.

While many producers had difficulties in various areas of product development, most noted their difficulties stemmed from the lack of personnel available to process and respond to such disasters. For instance, Jackson County currently has only two trained GIS personnel on staff. Also, Harrison County noted a lack of available staff with GIS capabilities able to assist during these efforts. Recovery efforts made by various agencies, Mississippi State University included, aided in this lack of personnel but also faced similar communication issues when they arrived to help with the response efforts.

Lastly, as previously noted, standards became the main focus of effective response efforts. The standardization of production, delivery, and use was found to be key among the producers’ opinions. Without standardized processes, the respondents noted that it would prove difficult to effectively manage and respond to disasters in the future. This standardization element was a focus of both local and first responders’ sessions and continues to be the focus of ongoing research into the development of future response and recovery efforts.

Ultimately, the responders provided valuable insight into the different hurdles and successes in their interactions during the Hurricane Katrina disaster response and recovery efforts. The idea of standards and formalized procedures based on emergency response standards proved to be the ideal goal of the individual producers. Also, the lack of identifiable methodologies proved to be a major hurdle in the ongoing response and recovery efforts. While some efforts seem fruitless, others were noted as having good success during these efforts and can be used as reference points for future efforts.
WRITTEN QUESTIONNAIRES
1. In the aftermath of Hurricane Katrina, did YOU or YOUR agency know spatial data were available and how these data could help in decision making processes? Most of the responders said that they did know about the data. One response did, however, say that they were not always sure of what to do with the data. Another stated that while they themselves had access to the data, a lot of the agencies they worked with did not.

2. What individual (job title) and/or which agency made requests for spatial products? Responders stated that a large variety of agencies made requests for products. Some of the often-cited ones were FEMA, MEMA, and DEQ. A couple of responses just said “everyone”.

3. What overall protocol was followed in making a request? Who was the first person YOU contacted? Did you make a phone call or e-mail your request? If more than one, how many people did you have to contact before your request was channeled to the proper authorities? There were a variety of responses. Most of the responders stated that basic map-making forms were generally used in making a request. One stated that map requests were handled in group discussion. One stated that most requests were made face-to-face, and that it was due to having a room at the EOC.

4. What was the request, and for what need was the request made? One responder provided a list of requests that were made: road maps for navigation, points of interest for navigation and planning, damaged areas for decision making, water flow models for search and rescue, and geocoding for emergency locating. Other responders listed rubbish disposal maps, PODs from FEMA for distribution coordination, and imagery from the Air Force for damage assessment.

5. When YOU had a decision to make and you knew a spatial product could possibly aid your in your decision, did you know HOW to ask a GIS person for the specific map product you needed? In other words, what were the communication barriers or failures, if any? Responders answered that they did know how to ask a GIS person for a specific map and that there generally were no barriers. One response stated that data was occasionally denied.
6. In your opinion, does YOUR agency now know how to access the data available? Are YOU better prepared in knowing who to contact for spatial products in the event of another natural or willful disaster?
   All responders answered that they do now know how to access the data, and that they are now even better prepared for the future.

**TIMING ISSUES AND PRODUCT DELIVERY (10:15 am – 11:00 am)**

1. Were the spatial products YOU requested supplied in time to meet the intended need or help make the decision at hand?
   Four responders stated that the products were supplied in time. One responder answered no.

2. If not, then in your opinion, what were the contributing circumstances that prevented a timely delivery?
   A few different responses were given. One gave data acquisitioning as a reason that data was not able to be provided on time, as they had the hardware, software, and time but not the data. Another cited miscommunication. A third response stated red tape as a reason.

3. Do the spatial data users in YOUR agency determine data request priorities within the agency before submitting requests to data providers?
   All responders answered yes.

4. If so, how do the data users in YOUR agency come to a consensus about data prioritization?
   One response stated that their prioritization list, in order, was EOC director, FEMA, and other agencies. A couple of responses simply stated whatever is needed first is prioritized. Another said that prioritization decisions were mostly made by the department director.

5. To expedite spatial data services, should data providers assign priorities to incoming data requests? If so, how could this be accomplished and what are the potential consequences?
   All but one responder said that data providers should assign priorities to incoming data requests, and said that first responders and most-damaged areas should come first. The other responder said that assigning a priority could limit a decision or action that might later turn out to be more important or time-sensitive that first believed.
6. In lieu of the above, should the data providers accept only authorized requests? Who would serve as the authorizing entity?
Three of the responders stated that data providers should not accept only authorized requests. Two said that they should only accept authorized requests, including one who was not sure who should authorize and the other who gave the state and FEMA as possible authorizing entities.

7. In your opinion, do the political influences that surround disaster situations mostly improve or hinder the efforts of data providers?
Four thought that political influences hindered the efforts of data providers. One thought that political influences improved the efforts. Another stated that it was some of both.
8. After being supplied the spatial product YOU requested, was the product appropriate for aiding in the specific decision for which it was intended?

Half of the 10 responders believed that the product was appropriate for their uses, while the other half believed it was not. Some of those who thought that the product was not effective for their needs said that it took too long to receive the imagery. A responder who worked with the organization making the maps said that maps were frequently misinterpreted by the end-users and users had to be told many times that a slosh model was a prediction, and not specifically calculated for the event. This responder also said that the maps had these types of disclaimers, but that no one read them.

9. How effective was the spatial product? Did it exceed or fail your expectations?

Half of the responders, 5 out of 10, felt that it exceeded their expectations. One of these responders, however, did admit that his/her expectations were very low. Out of the other half of the responders, two felt that it failed. One of those two stated that streets were very hard to find on the map due to the missing road signs from Katrina and added that they had to count streets from known landmarks to find a specific one. The other said there were major data problems at the local level. The other three responders were mixed in their response. One of these was a member of the map-making organization and said it took several drafts to create a sufficient product because people often did not fully explain their needs. Another of the responders with a mixed answer said that products relying on very accurate parcel, road, or addressing data could have been better.

10. Was the map useful in other decision making activities?

All of the responders who answered the question said that it was useful if other decision making activities. One said it helped to map road closures and route EMTs. Another said that it helped in identifying parcels over a certain number of areas. A third said it caused more search and rescue operations to be successful. One other responder said that they were continually surprised by the innovative use and reuse of maps by first responders.

11. What improvements would you suggest to make the spatial product more useful?

There were a large variety of improvements suggested. One responder suggested that the maps be created in an easier-to-understand format for end-users. Another suggested that “map books” be used and maps be printed on Tyvek paper with waterproof ink. Others suggested open access to
current and accurate post-event data, faster delivery, rectified imagery, standardized symbology, standardized map requests, longitude and latitude on all points-of-interests, and a sustainable process for local maintenance of the maps.

12. Would you use dated map products (products intended for another purpose) to aid in your decision making instead of attempting to get the most recent product available?
   Most responders, 11, said that they would use dated map products. Almost all agreed, however, that dated products only be used if no updated products were available. A couple of other responders were adamantly opposed to dated products, but still said that they would use them if nothing newer was available.

13. What are the critical map themes that should be considered most important in the resiliency efforts of a region after a disaster?
   Responders gave a lot of themes that they believed to be most important. Some of the most common answers were road maps, parcel maps, maps showing health and survival products (water, ice, etc.), transportation maps, maps showing population density, and utility infrastructure maps.

PREPAREDNESS AND RESILIENCY (1:45 pm – 2:30 pm)

1. In your opinion, do you feel WE, (1) as the State of Mississippi and (2) as a nation, are better prepared for a natural or willful disaster than we were before Hurricane Katrina?
   Most responders felt that the state of Mississippi and the nation are now better prepared for a natural or willful disaster, but many also agreed that more could still be done. A few responders felt that Mississippi is better prepared due to the integration of things such as GIS, but that the nation is not better prepared, mainly due to the lack of communication between local, state, and national levels. Along with this reason, most of those who felt that neither Mississippi nor the nation is better prepared also believed that data and resources need to be stored and allocated more efficiently.

2. Do you consider YOURSELF to be better prepared, less prepared, or about the same level of preparedness for a disaster event since Hurricane Katrina?
   Almost all of the responders, 13 out 16, said they believed themselves to now be better prepared for a disaster event. The other three responders said they were at about the same level of preparedness.
3. In YOUR opinion, does the time consumed requesting and interpreting spatial products increase the vulnerability of a situation to any degree?
   About half of the responders believed that requesting and interpreting spatial products increased the vulnerability of a situation. However, some of those responders believed that a misinterpretation of data could make things even worse. The other half of responders believed that it did not.

4. In an ideally design system, does the integration of spatial product production and use in a disaster situation increase the resiliency of the affected region? What are key points to consider?
   All of the responders said that the integration of spatial products does increase the resiliency of the affected region. One of the responders did believe the integration helped but believed the question was too pointed. Responders mentioned lots of key points to consider, including data currency, the timely delivery of products, two-way feedback between production and use, local data levels, and having a backup offsite for data with a local redundant copy.
SUMMARY

Natural and willful disaster response and recovery efforts require a collaboration of various agencies and organizations working together to contribute to the production of spatial products necessary to first responders’ efforts. While this session would have been better served with a greater participation of first responders, it provided a framework for a future web-based survey aimed at gaining more insight into the effectiveness of spatial products during response and recovery efforts in the wake of disasters. The Social Science Research Center at Mississippi State University is implementing these suggestions and ideas in the development of a web-based survey intended to gain a larger response from the community of geospatial users.

While this workshop focused on collecting responses from various federal, state, and local agencies as well as first responders, the implementation of a broader reaching survey will help gain the opinions, beliefs and attitudes of a greater number of individuals. In turn, the gathered results from this survey will provide valuable input for the development of the GIS data delivery system proposed by the research team.

Upon completion of the web-based survey and the GIS data delivery system, the SSRC, along with the GeoResources Institute and Oak Ridge National Laboratories, will host a follow-up workshop aimed at gathering feedback about the newly developed system and potential future implications gained from the insight of the survey instrument.
Appendix B

Map User Questionnaire
SPATIAL DATA USERS
Hurricane Katrina – Lessons Learned Questionnaire

The following questionnaire attempts to capture some of the knowledge, opinions and beliefs of those involved with spatial products (using or producing maps) for Hurricane Katrina response and recovery efforts. Your answers to these questions will help data providers develop systems that could be more beneficial to response and recovery efforts in future disasters. We thank you for your participation!

Read the questions carefully and answer them to the best of your ability. Your answers will be kept in strict confidence and will remain anonymous. You may refuse to answer any question, and you may stop the survey at any time. Again, thank you!

Which of the following best describes your role with regards to using or producing maps (spatial products) during Hurricane Katrina response and recovery efforts?

☐ I considered myself more of a map user (eg., used maps to aid in my field response and recovery efforts and/or decision-making processes)
☐ I considered myself more of a map producer (eg., map maker, GIS person, data analyst or data management person)
☐ I was not using or producing maps (spatial products) related to Katrina
☐ Don’t Know/Don’t Remember
☐ I do not want to participate in this study

I. Communication

a. Before Hurricane Katrina, did you know that there was a GIS (map making) arm to Emergency Operations Centers (EOCs)?
   ☐ Yes
   ☐ No
   ☐ Don’t Know/Don’t Remember
   ☐ No Comment

b. Where did you first hear of the availability of maps for aid in response and recovery efforts in the aftermath of Katrina? Did you hear it from:
   ☐ FEMA or MEMA
   ☐ the Emergency Operations Center (EOC),
   ☐ within your own organization, or
   ☐ a third party also involved in response/recovery efforts?
   ☐ Other(Please specify)________________________________________
   ☐ Don’t Know/Don’t Remember
   ☐ No Comment
c. How often were you in DIRECT CONTACT with the individual(s) responsible for the map production? Would you say:
   - Very Often,
   - Often,
   - Seldom, or
   - Never
   - Don’t Know/Don’t Remember
   - No Comment

d. Where did you spend the majority of your time while contributing to the response and recovery efforts after Katrina? Would you say:
   - in an office setting,
   - outdoors-in the field, or
   - about an equal amount of time outdoors and in an office?
   - Don’t Know/Don’t Remember
   - No Comment

e. What channel of communication did you use MOST of the time when you requested a map? Would you say:
   - Face-to-Face,
   - Telephone (land line),
   - Cell Phone,
   - Internet/E-mail requests, or a
   - 2-way Wireless Communication Device?
   - Other:(please specify) ______________________________
   - Don’t Know/Don’t Remember
   - No Comment

f. How effective was your most of used method of communication? (Were you able to communicate your needs?) Was it:
   - Very Effective,
   - Somewhat Effective,
   - Neutral,
   - Somewhat Ineffective,
   - Very Ineffective?
   - Don’t Know/Don’t Remember
   - No Comment

g. As a map user, did you have trouble communicating your needs to map producers? Would you say:
   - Most of the time,
   - Some of the time,
   - I had no trouble most of the time?
   - Don’t Know/Don’t Remember
   - No Comment
h. Should the role of a GIS Manager in a disaster situation include bridging communication gaps between disparate groups of individuals or agencies, such as the gaps between map users and map producers?
   - Yes
   - No
   - Don’t Know/Not Sure
   - No Comment

II. Product Delivery

a. How effective was the TIMING of map delivery with respect to meeting your needs or making decisions? Was it:
   - Very Effective,
   - Somewhat Effective,
   - Neutral,
   - Somewhat Ineffective,
   - Very Ineffective?
   - No Comment

b. Did you or your agency prioritize map requests in any way?
   - Yes, my agency did
   - Yes, I did
   - Yes, we both did
   - No
   - Don’t Know/Not Sure
   - No Comment
   - Please briefly explain how map requests were prioritized:

________________________________________________________________________
________________________________________________________________________
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________________________________________________________________________
________________________________________________________________________
c. In a disaster situation, should data or map requests be authenticated, authorized, or both before work begins to fulfill the requests? Should they be:

- Authenticated Only,
- Authorized Only,
- Both Authenticated AND Authorized, or
- Neither Authenticated NOR Authorized?
- Don’t Know/Not Sure
- No Comment

d. Considering the response and recovery efforts after Hurricane Katrina, please rate how the following effected the availability of map products:

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<th></th>
<th>Very Negative Effect</th>
<th>Negative Effect</th>
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<td>Data Owners</td>
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</table>

e. Was communication, technology, or denied access the LARGEST barrier to accessing data or maps?

- Communication
- Technology
- Denied access
- Some Other Barrier (Please Specify)
- Don’t know/Don’t Remember
- No Comment

f. How satisfied were you with the delivery of map products during the aftermath of Hurricane Katrina? Were you:

- Very Satisfied,
- Somewhat Satisfied,
- Neutral,
- Somewhat Dissatisfied,
- Dissatisfied?
- Don’t Know/Not Sure
- No Comment
g. During the first 5 days after Hurricane Katrina were you primarily located:
   - On the Gulf Coast south of Interstate 10;
   - On the Gulf Coast north of Interstate 10;
   - In Jackson, MS; or
   - In Washington, D.C.?
   - Other (Please Specify): ______________________________
   - Don’t Know/Don’t Remember
   - No Comment

h. After the first five days following Hurricane Katrina, were you primarily located:
   - On the Gulf Coast south of Interstate 10;
   - On the Gulf Coast north of Interstate 10;
   - In Jackson, MS; or
   - In Washington, D.C.?
   - Other (Please Specify): ______________________________
   - Don’t Know/Don’t Remember
   - No Comment

i. During the first 5 days after Hurricane Katrina, how far were you typically located from the nearest Emergency Operations Center (EOC)?
   - 0 miles (work at or next to an EOC)
   - 1 to 2 miles
   - 2 to 5 miles
   - 5 to 10 miles
   - 10+ miles
   - Don’t Know/Don’t Remember
   - No Comment

j. After the first five days following Hurricane Katrina, how far were you typically located from the nearest Emergency Operations Center (EOC)?
   - 0 miles (work at or next to an EOC)
   - 1 to 2 miles
   - 2 to 5 miles
   - 5 to 10 miles
   - 10+ miles
   - Don’t Know/Don’t Remember
   - No Comment
III. Map Effectiveness

a. How difficult was it to read and understand the map(s) supplied to you? Was it:
   - Very Difficult,
   - Somewhat Difficult,
   - Neither Difficult nor Easy,
   - Easy, or
   - Very Easy?
   - Don’t Know/Not Sure
   - No Comment

b. How effective was the map(s) in helping you make a decision? Was it:
   - Very Effective,
   - Somewhat Effective,
   - Neutral,
   - Somewhat Ineffective, or
   - Very Ineffective?
   - Don’t Know/Not Sure
   - No Comment

c. How effective was the map(s) in helping you meet your needs? Was it:
   - Very Effective,
   - Somewhat Effective,
   - Neutral,
   - Somewhat Ineffective, or
   - Very Ineffective?
   - Don’t Know/Not Sure
   - No Comment

d. How often did you have no alternative but to base your decisions on map information that you believed to be dated, incomplete, or less credible than your expectations? Was it:
   - Very Often,
   - Often,
   - Neither Often nor Seldom,
   - Seldom, or
   - Very Seldom?
   - Don’t Know/Not Sure
   - No Comment
e. To what degree do you think disaster response and recovery map products should be standardized or customized? Do you think they should:
   - Standardize all map products,
   - Standardize most map products and customize few,
   - Equal production of standardized and customized products,
   - Customize most map products and standardize few, or
   - Customize all map products?
   - Don’t Know/Not Sure
   - No Comment

f. How critical is each theme to response and recovery efforts?

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<th>Very Critical</th>
<th>Somewhat Critical</th>
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IV. Preparedness and Resiliency

The response efforts put forth by some organizations in the aftermath of Hurricane Katrina have been scrutinized by many people and from several different perspectives. The following questions are intended to gauge how YOU perceive the prior and current preparedness status of some of these organizations in the event of another disaster:

a. Within the first 5 days after landfall of Hurricane Katrina, how would you rate the response of FEMA?
   □ Excellent
   □ Very Good
   □ Good
   □ Fair
   □ Poor
   □ Don’t Know/Not Sure
   □ No Comment

b. Within the first 5 days after landfall of Hurricane Katrina, how would you rate the response of MEMA?
   □ Excellent
   □ Very Good
   □ Good
   □ Fair
   □ Poor
   □ Don’t Know/Not Sure
   □ No Comment

c. Within the first 5 days after landfall of Hurricane Katrina, how would you rate the effectiveness of the EOCs?
   □ Excellent
   □ Very Good
   □ Good
   □ Fair
   □ Poor
   □ Don’t Know/Not Sure
   □ No Comment
d. After the first 5 days following the landfall of Hurricane Katrina, how would you rate the response of FEMA?
   - Excellent
   - Very Good
   - Good
   - Fair
   - Poor
   - Don’t Know/Not Sure
   - No Comment

e. After the first 5 days following the landfall of Hurricane Katrina, how would you rate the response of MEMA?
   - Excellent
   - Very Good
   - Good
   - Fair
   - Poor
   - Don’t Know/Not Sure
   - No Comment

f. After the first 5 days following the landfall of Hurricane Katrina, how would you rate the effectiveness of the EOCs?
   - Excellent
   - Very Good
   - Good
   - Fair
   - Poor
   - Don’t Know/Not Sure
   - No Comment

Compared to the status **BEFORE** Hurricane Katrina, please answer the following questions below (g-l):

g. Is **FEMA** (federal level government) currently better prepared for the next disaster whether it is a hurricane or some other disaster? Would you say:
   - Much Better,
   - Slightly Better,
   - Neither Better nor Worse,
   - Slightly Worse, or
   - Much Worse?
   - Don’t Know/Not Sure
   - No Comment
h. Is MEMA (state level government) currently better prepared for the next disaster whether it is a hurricane or some other disaster? Would you say:

- Much Better,
- Slightly Better,
- Neither Better or Worse,
- Slightly Worse, or
- Much Worse?
- Don’t Know/Not Sure
- No Comment

i. How EFFICIENT will the Emergency Operations Centers (EOCs) be in the next disaster? Do you think they will be:

- Much More Efficient,
- Slightly More Efficient,
- Neither More or Less Efficient (would be the same as Katrina),
- Slightly Less Efficient, or
- Much Less Efficient?
- Don’t Know/Not Sure
- No Comment

j. How EFFECTIVE will the Emergency Operations Centers (EOCs) be in the next disaster? Do you think they will be:

- Much More Effective,
- Slightly More Effective,
- Neither More or Less Effective (would be the same as Katrina),
- Slightly Less Effective, or
- Much Less Effective?
- Don’t Know/Not Sure
- No Comment

k. Currently how prepared is your agency for the next disaster, be it a hurricane or some other disaster? Will your agency be:

- Much Better,
- Slightly Better,
- Neither Better or Worse,
- Slightly Worse, or
- Much Worse?
- Don’t Know/Not sure
- No Comment
l. Are **YOU** better prepared for the next disaster whether it is a hurricane or some other disaster? Would you say:
   - [ ] Much Better,
   - [ ] Slightly Better,
   - [ ] Neither Better or Worse,
   - [ ] Slightly Worse, or
   - [ ] Much Worse?
   - [ ] Don’t Know/Not Sure
   - [ ] No Comment

m. Do you have any ideas we did not cover about how to better use or produce spatial products to improve the response and recovery efforts in future disasters?

   If so, please share your ideas:
Appendix C

Map Producer Questionnaire
SPATIAL DATA PRODUCERS
Hurricane Katrina – Lessons Learned Questionnaire

The following questionnaire attempts to capture some of the knowledge, opinions and beliefs of those involved with spatial products (using or producing maps) for Hurricane Katrina response and recovery efforts. Your answers to these questions will help data providers develop systems that could be more beneficial to response and recovery efforts in future disasters. We thank you for your participation!

Read the questions carefully and answer them to the best of your ability. You answers will be kept in strict confidence and will remain anonymous. You may refuse to answer any question, and you may stop the survey at any time. Again, thank you!

Which of the following best describes your role with regards to using or producing maps (spatial products) during Hurricane Katrina response and recovery efforts?

☐ I considered myself more of a map user (eg., used maps to aid in my field response and recovery efforts and/or decision-making processes)
☐ I considered myself more of a map producer (eg., map maker, GIS person, data analyst or data management person)
☐ I was not using or producing maps (spatial products) related to Katrina
☐ Don’t Know/Don’t Remember
☐ I do not want to participate in this study

V. Communication

a. How often were you in direct contact with the individual map user?
   ☐ Very Often
   ☐ Often
   ☐ Seldom
   ☐ Never
   ☐ Don’t Know/Not Sure
   ☐ No Comment

b. Where did you spend the majority of your time while contributing to the response and recovery efforts after Katrina? Would you say:
   ☐ in an office setting,
   ☐ outdoors-in the field, or
   ☐ about an equal amount of time outdoors and in an office?
   ☐ Don’t Know/Don’t Remember
   ☐ No Comment
c. What channel of communication did you use MOST of the time when you requested a map? Would you say:
   □ Face-to-Face,
   □ Telephone (land line),
   □ Cell Phone,
   □ Internet/E-mail requests, or a
   □ 2-way Wireless Communication Device?
   □ Other:(please specify) _________________________________
   □ Don’t Know/Don’t Remember
   □ No Comment

d. How effective was your most of used method of communication? (Were you able to communicate your needs?) Was it:
   □ Very Effective,
   □ Somewhat Effective,
   □ Neutral,
   □ Somewhat Ineffective,
   □ Very Ineffective?
   □ Don’t Know/Don’t Remember
   □ No Comment

e. How often did you have trouble translating the needs of others into GIS products? Would you say:
   □ Most of the time,
   □ Some of the time, or
   □ I had no trouble communicating clearly with others?
   □ Don’t Know/Don’t Remember
   □ No Comment

f. Should the role of a GIS Manager in a disaster situation include bridging communication gaps between disparate groups of individuals or agencies, such as the gaps between map users and map producers?
   □ Yes
   □ No
   □ Don’t Know/Not Sure
   □ No Comment
VI. Product Delivery

a. How reasonable was the **TIME GIVEN** to complete map making tasks? Would you say:
   - [ ] Very Reasonable,
   - [ ] Somewhat Reasonable,
   - [ ] Neither Reasonable nor Unreasonable,
   - [ ] Somewhat Unreasonable,
   - [ ] Very Unreasonable?
   - [ ] Don’t Know/Don’t Remember
   - [ ] No Comment

b. Did you or your agency prioritize map requests in any way?
   - [ ] Yes, my agency did
   - [ ] Yes, I did
   - [ ] Yes, we both did
   - [ ] No
   - [ ] Don’t Know/Not Sure
   - [ ] No Comment
   - [ ] Please briefly explain how map requests were prioritized:

   __________________________________________________________
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________

C. In a disaster situation, should data or map requests be authenticated, authorized, or both before work begins to fulfill the requests? Should they be:

   - [ ] Authenticated Only,
   - [ ] Authorized Only,
   - [ ] Both Authenticated AND Authorized, or
   - [ ] Neither Authenticated NOR Authorized?
   - [ ] Don’t Know/Not Sure
   - [ ] No Comment
d. Considering the response and recovery efforts after Hurricane Katrina, please rate how the following effected the availability of map products:

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<th></th>
<th>Very Negative Effect</th>
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</table>

e. Was communication, technology, or denied access the LARGEST barrier to accessing data or maps?
   - Communication
   - Technology
   - Denied access
   - Some Other Barrier (Please Specify)
   - Don’t know/Don’t Remember
   - No Comment

f. How satisfied were you with the delivery of map products during the aftermath of Hurricane Katrina? Were you:
   - Very Satisfied,
   - Somewhat Satisfied,
   - Neutral,
   - Somewhat Dissatisfied,
   - Dissatisfied?
   - Don’t Know/Not Sure
   - No Comment

g. During the first 5 days after Hurricane Katrina were you primarily located:
   - On the Gulf Coast south of Interstate 10;
   - On the Gulf Coast north of Interstate 10;
   - In Jackson, MS; or
   - In Washington, D.C.?
   - Other (Please Specify): ______________________________
   - Don’t Know/Don’t Remember
   - No Comment
h. After the first five days following Hurricane Katrina, were you primarily located:
   - On the Gulf Coast south of Interstate 10;
   - On the Gulf Coast north of Interstate 10;
   - In Jackson, MS; or
   - In Washington, D.C.?
   - Other (Please Specify): _______________________________
   - Don’t Know/Don’t Remember
   - No Comment

i. During the first 5 days after Hurricane Katrina, how far were you typically located from the nearest Emergency Operations Center (EOC)?
   - 0 miles (work at or next to an EOC)
   - 1 to 2 miles
   - 2 to 5 miles
   - 5 to 10 miles
   - 10+ miles
   - Don’t Know/Don’t Remember
   - No Comment

j. After the first five days following Hurricane Katrina, how far were you typically located from the nearest Emergency Operations Center (EOC)?
   - 0 miles (work at or next to an EOC)
   - 1 to 2 miles
   - 2 to 5 miles
   - 5 to 10 miles
   - 10+ miles
   - Don’t Know/Don’t Remember
   - No Comment

VII. Map Effectiveness

a. How often did data availability or data access issues prevent you from making the map product you intended to make for users in the field? Was it:
   - Very Often,
   - Often,
   - Neither Often nor Seldom,
   - Seldom, or
   - Very Seldom?
   - Don’t Know/Not Sure
   - Don’t Know/Not Sure
   - No Comment
b. How much of an effect did long working hours and sleep deprivation have on your ability to affectively produce maps for users in the field?
   - A lot,
   - Some,
   - Little,
   - Very Little, or
   - None?
   - Don’t Know/Not Sure
   - No Comment

c. To what degree do you think disaster response and recovery map products should be standardized or customized? Do you think they should:
   - Standardize all map products,
   - Standardize most map products and customize few,
   - Equal production of standardized and customized products,
   - Customize most map products and standardize few, or
   - Customize all map products?
   - Don’t Know/Not Sure
   - No Comment
d. How critical is each theme to response and recovery efforts?

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<th>Theme</th>
<th>Very Critical</th>
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VIII. Preparedness and Resiliency

The response efforts put forth by some organizations in the aftermath of Hurricane Katrina have been scrutinized by many people and from several different perspectives. The following questions are intended to gauge how YOU perceive the prior and current preparedness status of some of these organizations in the event of another natural or willful disaster:

a. Within the first 5 days after landfall of Hurricane Katrina, how would you rate the response of FEMA?
   - Excellent
   - Very Good
   - Good
   - Fair
   - Poor
   - Don’t Know/Not Sure
   - No Comment

b. Within the first 5 days after landfall of Hurricane Katrina, how would you rate the response of MEMA?
   - Excellent
   - Very Good
   - Good
   - Fair
   - Poor
   - Don’t Know/Not Sure
   - No Comment

c. Within the first 5 days after landfall of Hurricane Katrina, how would you rate the effectiveness of the EOCs?
   - Excellent
   - Very Good
   - Good
   - Fair
   - Poor
   - Don’t Know/Not Sure
   - No Comment
d. After the first 5 days following the landfall of Hurricane Katrina, how would you rate the response of FEMA?
- Excellent
- Very Good
- Good
- Fair
- Poor
- Don’t Know/Not Sure
- No Comment

e. After the first 5 days following the landfall of Hurricane Katrina, how would you rate the response of MEMA?
- Excellent
- Very Good
- Good
- Fair
- Poor
- Don’t Know/Not Sure
- No Comment

f. After the first 5 days following the landfall of Hurricane Katrina, how would you rate the effectiveness of the EOCs?
- Very Good
- Good
- Neutral
- Poor
- Very Poor
- Don’t Know/Not Sure
- No Comment

Compared to the status **BEFORE** Hurricane Katrina, how would you answer the following questions (g-l):

**g.** Is **FEMA** (federal level government) currently better prepared for the next disaster whether it is a hurricane or some other disaster? Would you say:
- Much Better,
- Slightly Better,
- Neither Better nor Worse,
- Slightly Worse, or
- Much Worse?
- Don’t Know/Not Sure
- No Comment
h. Is MEMA (state level government) currently better prepared for the next disaster whether it is a hurricane or some other disaster? Would you say:
- Much Better,
- Slightly Better,
- Neither Better or Worse,
- Slightly Worse, or
- Much Worse?
- Don’t Know/Not Sure
- No Comment

i. How EFFICIENT will the Emergency Operations Centers (EOCs) be in the next disaster? Do you think they will be:
- Much More Efficient,
- Slightly More Efficient,
- Neither More or Less Efficient (would be the same as Katrina),
- Slightly Less Efficient, or
- Much Less Efficient?
- Don’t Know/Not Sure
- No Comment

j. How EFFECTIVE will the Emergency Operations Centers (EOCs) be in the next disaster? Do you think they will be:
- Much More Effective,
- Slightly More Effective,
- Neither More or Less Effective (would be the same as Katrina),
- Slightly Less Effective, or
- Much Less Effective?
- Don’t Know/Not Sure
- No Comment

k. Currently how prepared is your agency for the next disaster, be it a hurricane or some other disaster? Will your agency be:
- Much Better,
- Slightly Better,
- Neither Better or Worse,
- Slightly Worse, or
- Much Worse?
- Don’t Know/Not sure
- No Comment
1. Are **YOU** better prepared for the next disaster whether it is a hurricane or some other disaster? Would you say:
   - Much Better,
   - Slightly Better,
   - Neither Better or Worse,
   - Slightly Worse, or
   - Much Worse?
   - Don’t Know/Not Sure
   - No Comment

m. Do you have any ideas we did not cover about how to better use or produce spatial products to improve the response and recovery efforts in future disasters?

   If so, please share your ideas:
Appendix 2

Final SSRC Technical Report and Survey Results Report

Authors: J.J. Dallas Breen and David R. Parrish

Social Science Research Center, Mississippi State University

July 21, 2008
EXECUTIVE SUMMARY

The Social Science Research Center (SSRC) at Mississippi State University (MSU) participated in a research effort that focused on lessons learned from the use of geospatial products in the aftermath of Hurricane Katrina. The project team was led by the GeoResources Institute (GRI) at MSU and collaborations were also enacted with Oak Ridge National Laboratories (ORNL) and a commercial partner, NVision Solutions, Inc. This research was administered by the Southeast Region Research Initiative (SERRI) for the Department of Homeland Security (DHS) and adheres to the goals and mission of DHS with specific regard to preparedness for future natural or willful disasters. The SSRC’s role in this research effort included an initial survey development workshop, the design and implementation of survey instruments to users and producers of geospatial data, and an end project workshop to gain feedback on the research findings.

The initial workshop was held as an information gathering approach aimed at collecting users and producers’ feedback regarding their opinions and experiences during the initial...
and subsequent weeks following Hurricane Katrina. The workshop was held at the Mississippi State University Coastal Research and Extension Center on August 7, 2007. The feedback resulting from this workshop served as a guide in developing the survey instrument that polled a much larger sampling of the geospatial product users and producers.

The survey was implemented in a mixed-mode (web-based and postal mail) approach aimed at gaining the largest amount of feedback possible. The survey participants were respondents who were part of a convenience sample population identified for the research project.

Number of questionnaires sent: 563
Number of rejected addresses due to false or incomplete addresses: 40
Number of completed surveys: 60
Response rate of 11%

Although the exact number of users and producers of geospatial data after Katrina is unknown, the resulting number of user responses (n = 44) and producer responses (n = 16) to the survey was considered acceptable by the project team to draw general conclusions. Likewise, it is impossible to know if the sample of survey respondents constitutes a representative sample of either of these two groups, but the consensus of the project team indicates there is a confidence in the number of participants and the findings resulting from the survey.

The survey focused on (1) person-to-person communication, (2) product delivery and timing issues, (3) map effectiveness in the decision making process, and (4) preparedness and resiliency estimation. From the survey results, the project team identified some major findings that clearly illustrate trends and the need for further research into the area of geospatial product use in disaster response and recovery efforts. The first of these finding is maps are universally considered to be an effective tool by users in the field. Almost 80% of map user respondents stated that maps were very effective or somewhat effective in the decision-making process. A second finding is the identification of five critical data layers for inclusion on map products. Survey results show that both user and producer respondents feel that roads, emergency services, supplies (food, water, ice), hospitals and telecommunications were the most critical layers for most map products during response and recovery efforts. The third major finding was with regard to data access issues. From the survey responses, more than 50% of map producer respondents stated that data availability or data access issues were very often or often the reason preventing the production of a map product intend for users in the field. A fourth finding is the common belief that standardization of map products is a highly desirable benefit to disaster response and recovery activities. The prevalent opinion among map users is that there should be equal production of both standardized and customized map products, while producers tend to believe that a more standardized approach may yield more beneficial results. The fifth and last major finding was the overall belief that local EOCs outperformed both FEMA and MEMA in response to the needs brought about by the storm.
The survey results also proved to be an invaluable tool for the project team to understand the needs of users and producers as they worked towards the development of a functioning map-viewer web portal.

Following completion of the survey dissemination and information gathering, the project team hosted a 1-day end-of-project workshop at GRI on June 25, 2008. Our guest professionals applauded our research efforts and concluded by encouraging the research team to present three to five top research findings to the Mississippi Coordinating Council for Remote Sensing and Geographic Information Systems (more commonly referred to as the MS GIS Council). This was stated with the hopes that the council would place emphasis on the research results and continue to recognize emergency response issues as a top priority in the State of Mississippi.

This research effort uncovered many other interesting results that can be found on the Katrina Lessons website at www.katrinalessons.msstate.edu. However, it should be noted that there is a need for more in-depth questioning of geospatial product users in response and recovery efforts. A better understanding of each culture’s standard operating procedures and their beliefs, opinions, and practices with regard to cartography, symbolism and characteristics for overall map effectiveness would be most beneficial to those who produce geospatial products.
INTRODUCTION

Disaster preparation, response, and recovery methods require the coordination of federal, state, and local agencies to effectively and efficiently cope with both natural and willful disasters. The utilization of Geographic Information Systems (GIS) allows individuals at each agency level to visualize disasters and coordinate their responses accordingly. However, as in the case of relief efforts after Hurricane Katrina, the inconsistencies in data collection, reporting, and dissemination coupled with mixed metadata development translate into disrupted and/or unusable data visualizations and information exchange to first responders and emergency agencies.

To gain a better understanding of the effectiveness of spatial data products developed in the wake of Hurricane Katrina, a “Katrina: Lessons Learned” research team was formed. The project team was lead by the GeoResources Institute (GRI) at Mississippi State University (MSU) and collaborations were enacted with Oak Ridge National Laboratories (ORNL), the Social Science Research Center (SSRC) at MSU and a commercial partner NVision Solutions, Inc. This research was administered by the Southeast Region Research Initiative (SERRI) for the Department of Homeland Security (DHS) and adheres to the goals and mission of DHS with specific regard to preparedness for future natural or willful disasters. Each entity was individually assigned a research thrust to be completed and synthesized into a cohesive end product deliverable. SSRC’s role in this research effort included an initial survey development workshop, the design and implementation of survey instruments to users and producers of geospatial data, and an end project workshop to gain feedback on the research findings. Further information
regarding the results of “Katrina Lessons: Phase I” can be found on the Katrina Lessons website at www.katrinalessons.msstate.edu.

The project team hosted and facilitated a survey development workshop, implemented a survey instrument derived from workshop input, and lastly, hosted a 1-day end project workshop to garner feedback regarding survey results and product usage. The initial workshop allowed the team to gain insight into the perspectives and input of emergency response decision makers at the federal, state and local levels. The feedback resulting from this workshop served as a guide in developing the survey instrument that polled a much larger sampling of the spatial product users and producers. The survey results provided an invaluable tool for the project team to understand the needs of users and producers as they worked towards the development of a functioning map-viewer web portal. The survey also provided the project team with previously unknown factors regarding users’ and producers’ experiences and opinions during the initial and subsequent phases of the Hurricane Katrina response and recovery efforts. Following the completion of the survey dissemination and information gathering, the project team hosted a 1-day end-of-project workshop. This small group of workshop attendees allowed for more personal interactions and candid feedback as the project team visually displayed the survey results. In addition, the group was given the opportunity to explore the virtual showcase developed by the project team; displaying the various spatial products and information gathered during the initial phase of the “Katrina: Lessons Learned” project. As a result, the team was able to synthesize the results of the two
workshops and the survey product, resulting in an initial base of lessons learned in Hurricane Katrina response and recovery efforts.

INITIAL WORKSHOP

The initial workshop was held as an information gathering approach aimed at collecting users and producers’ feedback regarding their opinions and experiences during the initial and subsequent weeks following Hurricane Katrina. The workshop was held at the Mississippi State University Coastal Research and Extension Center on August 7, 2007. The workshop was targeted towards a group of “users of spatial product information for decision making”. While this target was not quite realized at the workshop, the workshop did provide insightful and incredibly useful feedback from the perspective of spatial product producers. Despite the lack of participation from first responders, the information from the first workshop was gathered and processed accordingly, providing input into the survey questionnaire development.

The workshop consisted of 2 breakout sessions, one morning and one in the afternoon, which were then divided into two groups. The groups were (1) federal and state agencies and (2) local and first responder agencies. Each group met in separate rooms and was given the same set of question topics for discussion. The concentrations for the morning breakout session were (1) person-to-person communication and (2) timing issues and product delivery. The focus topics of the afternoon breakout session were (3) map effectiveness and (4) preparedness and resiliency. The project team then proceeded to lead the groups in discussions regarding the various question topics and collected the
feedback from the group. The workshop report was compiled detailing the various findings and feedback provided by the breakout sessions and by the general discussion. One encapsulating outcome of the workshop verified the seemingly obvious assumption that natural and willful disaster response and recovery efforts require a unique collaboration among various agencies and organizations working together to contribute to the production of spatial products necessary to first response efforts. Another major outcome of the workshop was that a critical component of effective disaster management is the rapid characterization of the extent of damage both pre- and post-Hurricane Katrina. This workshop focused on collecting this type of feedback from targeted individuals from federal, state, and local emergency response agencies for use as an aid in the development of a broader reaching survey to gain the opinions, beliefs and attitudes of a greater number of disaster response individuals. In turn, the gathered results from this survey provided valuable input for the development of the GIS data delivery system by the project team. A more detailed report regarding the initial project workshop is located in Appendix A.

SURVEY QUESTIONNAIRE RESULTS

Capitalizing on the Social Science Research Center’s extensive history of surveying and their collective social science expertise, the project team developed a survey instrument using feedback from the initial workshop group in addition to input by various GIS and first response individuals. The survey was implemented in a mixed-mode (web-based and postal mail) approach aimed at gaining the largest amount of feedback possible. The survey participants were respondents who were part of a convenience sample population
identified for the research project. A convenience sample was utilized due to the nature of the survey questionnaire and the limited number of known contacts involved in the response and recovery efforts following Hurricane Katrina. The results of the survey proved to be an informative look into the experiences, attitudes, and beliefs of both users and producers of geospatial information with respect to the Katrina aftermath.

The survey instrument was disseminated using contact lists from NVision Solutions, Inc., the GeoResources Institute, MSU and from the Mississippi State University Extension Service Center for Government Technology and Training. The latter was contacted with the hopes of using their vast contacts in the first responders and public services sectors. With cooperation from the Center for Government Technology and Training, the project team was able to blanket the state of Mississippi with surveys to first response individuals in each of the 82 counties. It should be noted that many of these responders may not have been a part of the Hurricane Katrina response and recovery efforts due to unknown factors. However, since the project team did not wish to exclude potential feedback from any that may have been involved, the project team disseminated the survey to the entire list. Response rates for the questionnaire can be seen in Table 1 below.
Table 1. Online Survey Questionnaire Results.

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<th>Online Questionnaire</th>
<th>Postal Mail Questionnaire</th>
<th>Overall Questionnaire</th>
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<tbody>
<tr>
<td>Number of Requests</td>
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<td>442</td>
<td>563</td>
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<tr>
<td>Number of False/Incomplete</td>
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<td>8</td>
<td>40</td>
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<td>Address Rejections</td>
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<td>Number of Assumed Successful</td>
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<td>434</td>
<td>523</td>
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<tr>
<td>Deliveries</td>
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<tr>
<td>Number of Completed Surveys</td>
<td>34</td>
<td>26</td>
<td>60</td>
</tr>
<tr>
<td>Response Rate</td>
<td>38%</td>
<td>6%</td>
<td>11%</td>
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The project team was pleasantly surprised by the response rate of the online questionnaire and by the overall feedback from the survey. Although the exact number of users and producers of geospatial data after Katrina is unknown, the resulting number of user responses (n = 44) and producer responses (n = 16) to the survey was considered acceptable by the project team to draw general conclusions. Likewise, it is impossible to know if the sample of survey respondents constitutes a representative sample of either of these two groups, but the consensus of the project team indicates there is a confidence in the number of participants and the findings resulting from the survey.

The survey focused on (1) person-to-person communication, (2) product delivery and timing issues, (3) map effectiveness in the decision making process, and (4) preparedness and resiliency estimation. These four areas of emphasis break the survey into sections for analysis and reporting. The results of the survey displayed varying experiences and beliefs, both comparable and contrasting, between map users and map producers. From these results, the project team identified some major findings that clearly illustrate trends and the need for further research into the area of geospatial product use in disaster
response and recovery efforts. A breakdown of the most compelling results is included in this report.

*Person-to-person communication*

Perhaps the most apparent and anticipated finding was that face-to-face communication was the main method of communication when requesting map products during the Hurricane Katrina response and recovery efforts. Of those responding, 59% of the map users and 64% of map producers indicated that face-to-face was the most frequently used method of communicating. When asked about the effectiveness of the above mentioned communication method, approximately 94% of users and 86% of producers found their face-to-face communication to be either very effective or at least somewhat effective (Figure 1). Essentially, users and producers agreed that, although most were reduced to having to communicate face-to-face in this disaster situation, the effectiveness of the communication method was favorable.

![Figure 1. Effectiveness of Chosen Method of Communication.](image)

Users (n = 44)  Producers (n = 14)


*Delivery and Timing*

Timing of the delivery of map products is crucial in disaster response efforts. Responders face numerous obstacles, perhaps the most notable being the lack of time to perform response and rescue operations. Obtaining map products in a timely fashion is critical to the effectiveness of first responders’ efforts. Figure 2 shows the overall opinion regarding the timing of map product delivery. Approximately 70 percent of map user respondents stated that the timing of map products was either *very effective* or *somewhat effective*. Therefore, map users indicated they received maps and spatial products in a timely fashion despite the hectic nature of the surrounding circumstances. Producers, on the other hand, were not quite as favorable in their responses. While there was no significant negative feedback regarding the time to produce map products, the producers failed to respond that the timing was very reasonable. Almost 63% of respondents stated that the timing was *somewhat reasonable* while another 32% said that it was *neither reasonable nor unreasonable*. These results show an apparent discrepancy between the producers and the users of map products. It seems perceptions of time to produce maps are more restrictive compared to the perceptions of map delivery times. Producers may be more inclined to take additional time to produce the most effective and efficient map products for users while most users seemed content with the timing of map deliveries.
During the initial workshop, individuals indicated data access problems were a common occurrence in their Katrina experience and that this type of barrier prevented the production of map products intended. From the survey responses, more than 50% of map producer respondents stated that data availability or data access issues were very often or often the reason preventing the production of a map product intended for users in the field. The actual response breakdown is shown below in Figure 3.
Data availability, or lack thereof, was a common theme throughout the initial phase of this project. The continuing concern was never more apparent than in the responses given by the survey respondents. Considering the timing of the disaster and the difficulties with field issues due to the devastation, some of the most often referenced problems revolved around data availability and access, both of which arise from areas not affected by the disaster. Those located at EOCs during the first five days after Hurricane Katrina and in the second and subsequent weeks noted very similar problems. Of the nine survey respondents located at an EOC, 67% noted that data availability or data access were very often or often the issues preventing them from making the intended map products.

**Map Effectiveness**

Map effectiveness proved to be one of the more intriguing and satisfying topics in the survey. As shown in Figure 4, almost 80% of map user respondents stated that maps were very effective or somewhat effective in decision-making.

Figure 4. Effectiveness of Spatial Products in Decision-Making (n = 40)
Most response and recovery decision-makers indicated the use of geospatial products was an effective tool. A majority of map product user respondents (78%) located at or near EOCs stated that the maps were either very effective or somewhat effective in helping meet their needs and making decisions. Only one respondent noted that map products were very ineffective in helping make a decision.

One of the more pointed questions for map users respondents asked how difficult it was to read and/or understand the map products supplied to them. Again, a majority of map user respondents (64%) stated it was very easy or easy to read and understand the map products supplied to them. However, 29% stated that it was either somewhat difficult or neither difficult nor easy to read and understand the supplied map products. Curiously, some users found little or no difficulty in understanding the map products supplied to them while others indicated reading or understanding the map products may have been a problem.

Another issue that arose from our initial workshop was idea of standardizing some map products for use in disaster situations. Map users and map producers were asked whether they think map products should be standardize or customized. They were also given the option to choose equal production of both standardized and customized, or more of one over another. Figures 5 and 5a show the breakdown of both user and producer respondents, as well as a combination of responses from both users and producers.
The prevalent opinion among users is that there should be equal production of both standardized and customized map products, while producers tend to believe that a more standardized approach may yield more beneficial results. One possible explanation may be that map producers believe more standardized maps would streamline production and get useful maps in the hands of decision-makers more swiftly. Users of map products...
may be biased towards more customized products that fit their specific needs without having the distraction of data layers which they do not consider to be useful.

Lastly, map users and producers were asked to gauge the importance each of the listed map layers in Figure 6 below. The respondents were given a five point scale from very critical to not critical at all and asked how critical are each of these layers were in disaster response and recovery efforts.

Figure 6. Critical Map Layers
Figure 6 also shows that both user and producer respondents feel that roads, emergency services, supplies (food, water, ice), hospitals and telecommunications were the most critical layers for most map products during response and recovery efforts. Certain layers were considered far less critical in the opinion of the respondents. Prisons, banking, and postal services were all rated far less critical than any of the other layers. One lower layer rating that is noteworthy and unexpected is the rating for parcel data. During the initial workshop, many comments were made regarding parcel data and how useful it would have been in the response and recovery efforts. Contrary to the attention received in the workshop, many respondents felt parcel data was not as critical as many of the other layers. One possible explanation could be some of the respondents may not be familiar with the word “parcel” or know the word’s meaning but may identify with the layer if it were included on a map. While this is a simple hypothetical speculation, it should be noted that parcel data rated fairly low in the survey responses.

**Preparedness and Resiliency**

The last portion of the questionnaire surveys respondents’ opinions concerning the effectiveness of FEMA, MEMA, and EOCs in the wake of Hurricane Katrina. They were asked to rate the effectiveness of each agency during the first five days after the storm and rate their performance again in the second and subsequent weeks. The scale for rating the agencies was a five point scale from excellent to poor. As can be seen in Tables 2 and 3, the survey results found that many feel FEMA and MEMA were not as effective as the local EOCs in meeting the many needs of this tattered region during the response and recovery efforts after the storm.
Table 2. Respondents Ratings of the Effectiveness of Emergency Response Agencies for the First Five Days after Katrina

<table>
<thead>
<tr>
<th>Effectiveness of Agency</th>
<th>FEMA (n = 58)</th>
<th>MEMA (n = 58)</th>
<th>EOCs (n = 58)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>8.6%</td>
<td>8.6%</td>
<td>17.2%</td>
</tr>
<tr>
<td>Very Good</td>
<td>13.8%</td>
<td>24.1%</td>
<td>20.7%</td>
</tr>
<tr>
<td>Good</td>
<td>22.4%</td>
<td>27.6%</td>
<td>27.6%</td>
</tr>
<tr>
<td>Fair</td>
<td>22.4%</td>
<td>19.0%</td>
<td>19.0%</td>
</tr>
<tr>
<td>Poor</td>
<td>22.4%</td>
<td>10.3%</td>
<td>0%</td>
</tr>
</tbody>
</table>

Table 3. Respondents Ratings of the Effectiveness of Emergency Response Agencies for the Second and Subsequent Weeks after Katrina

<table>
<thead>
<tr>
<th>Effectiveness of Agency</th>
<th>FEMA (n = 58)</th>
<th>MEMA (n = 58)</th>
<th>EOCs (n = 58)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>8.6%</td>
<td>6.9%</td>
<td>19.0%</td>
</tr>
<tr>
<td>Very Good</td>
<td>17.2%</td>
<td>25.9%</td>
<td>32.8%</td>
</tr>
<tr>
<td>Good</td>
<td>29.3%</td>
<td>34.5%</td>
<td>25.9%</td>
</tr>
<tr>
<td>Fair</td>
<td>25.9%</td>
<td>20.7%</td>
<td>6.9%</td>
</tr>
<tr>
<td>Poor</td>
<td>17.2%</td>
<td>5.2%</td>
<td>0%</td>
</tr>
</tbody>
</table>

Furthermore, the respondents were asked to offer their beliefs regarding the preparedness of FEMA, MEME, EOCs, as well as themselves for future disasters. Just over half of the map user respondents feel that they are much better prepared for a disaster following their
Hurricane Katrina experience. Map producers as a whole also feel they are better prepared, although there are a few responses of neither better nor worse prepared in the survey findings. While most say they are personally much better or slightly better prepared, there is a slightly downgraded opinion of their agency’s preparedness in the event of another disaster, as seen in Figures 7 and 7a. It is interesting that as a group the respondents do not share quite the same optimism for their respective agencies.

Figure 7. Personal Preparedness for a Future Disaster (n=58)

![Pie chart showing personal preparedness for a future disaster]

Figure 7a. Agency Preparedness for a Future Disaster (n=55)

![Pie chart showing agency preparedness for a future disaster]
Summary

The Katrina Lessons project team lead by the GeoResources Institute at MSU and in collaboration with Oak Ridge National Laboratories, the Social Science Research Center at MSU, and NVision Solutions, Inc. combined their research efforts in an attempt to learn lessons from the use of geospatial products during the Hurricane Katrina aftermath. The SSRC’s role in this research effort included an initial survey development workshop, the design and implementation of survey instruments to users and producers of geospatial data, and an end project workshop to gain feedback on the research findings.

SSRC’s major thrust was the development and implementation of a survey to users and producers of geospatial data (maps) in the wake of Hurricane Katrina. From the survey results, the project team identified some major findings that illustrate the need for further research into the area of geospatial product use in disaster response and recovery efforts. The first of these findings is maps are universally considered to be an effective tool by users in the field. Almost 80% of map user respondents stated that maps were very effective or somewhat effective in decision-making. A second finding is the identification of five critical data layers for inclusion on map products. Survey results show that both user and producer respondents feel that roads, emergency services, supplies (food, water, ice), hospitals and telecommunications were the most critical layers for most map product during response and recovery efforts. The third major finding was with regard to data access issues. From the survey responses, more than 50% of map producer respondents stated that data availability or data access issues were very often or often the reason preventing the production of a map product intend for users in the field.
A forth major finding is the common belief that standardization of map products is a highly desirable benefit to disaster response and recovery activities. The prevalent opinion among map users is that there should be equal production of both standardized and customized map products, while producers tend to believe that a more standardized approach may yield more beneficial results. The fifth and last major finding was the overall belief that local EOCs outperformed both FEMA and MEMA in response to the needs brought about by the storm.

This research effort uncovered many other interesting results that can be found on the Katrina Lessons website at www.katrinalessons.msstate.edu. However, it should be noted that there is a need for more in-depth questioning of geospatial product users in response and recovery efforts. A better understanding of each culture’s standard operating procedures and their beliefs, opinions, and practices with regard to cartography, symbolism and characteristics for overall map effectiveness would be most beneficial to those who produce geospatial products.
PROJECT END WORKSHOP

At the end of the Capturing Hurricane Katrina Data for Analysis and Lessons-Learned Project the research team held a 1-day end-of-project workshop at GRI on June 25, 2008 to gain outside perspectives on the findings and outcomes of the project. The 1-day workshop was conducted in lieu of the 2-day symposium due to the registered attendance of a smaller group. There were eighteen invitations sent requesting participation and we were honored with presence of two outstanding professionals. The following are their names and affiliations:

1. Dr. Henrique Momm, University of Mississippi
2. Mr. Craig Ogeron, Mississippi Department of Information Technology Services

Dr. Momm and Mr. Ogeron provided an array of relevant feedback that was well received by the project team. The team members in attendance at this workshop were as follows:

1. Dr. Bill Cooke, GRI/MSU
2. Ms. Rekha Pillai, GRI/MSU
3. Mr. Joel Lawhead, NVision Solutions, Inc.
4. Mr. J.J. “Dallas” Breen, SSRC/MSU
5. Mr. David R. Parrish, SSRC/MSU

The project team gave presentations commensurate with the findings and developments of the research project. Dr. Cooke gave an overview of the project scope, a recap of the Fall 2007 Workshop in Biloxi, MS, and specifically outlined the objectives of the research. Mr. Breen and Mr. Parrish presented findings from a survey that was developed for users and producers of spatial data in the Katrina disaster. Mr. Lawhead informed the group of the results of the GIS-based, community level application
development for disaster response. And lastly, Dr. Cooke and Ms. Pillai demonstrated the function and capability of the newly developed interface and enterprise database and analysis system for disaster response.

Throughout the presentations questions and comments enhanced the collaborative discussion. One such topic of discussion was the finding of five critical spatial data layers (roads, emergency services, food/water/ice supplies, hospitals and telecommunications) according to the polling of 60 survey participants. These layers were also thought to be an important discovery by our guest participants. The group noted that these layers should somehow be standardized in terms of their cartographic elements and symbology to allow much faster interpretations by various response cultures in future disaster situations.

Our guest professionals concluded by encouraging the research team to present three to five top research findings to the Mississippi Coordinating Council for Remote Sensing and Geographic Information Systems (more commonly referred to as the MS GIS Council). This was stated with the hopes that the council would place emphasis on the research results and continue to recognize emergency response issues as a top priority in the State of Mississippi.

Although there were not as many workshop participants as anticipated, the overall result of the workshop was believed to be a success. Dr. Henrique Momm and Mr. Craig Ogeron provided the research team with valuable feedback and an outside perspective of
the project results. Their expertise aided in honing our output for future presentations of
the spatial data users/producers survey results, the community geospatial application
developments, and the demonstration of the enterprise database and analysis system for
disaster response.
Appendix 3.

Geospatial Applications for International Disasters
Applications of Geospatial Technology in International Disasters and During Hurricane Katrina

Chelsea DeCapua
Oak Ridge National Laboratory
August 2007
Applications of Geospatial Technology in International Disasters and During Hurricane Katrina

Chelsea DeCapua
Rochester Institute of Technology, Rochester, NY
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Budhendra Bhaduri
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Abstract
The Oak Ridge National Laboratory and Mississippi State University are collaborating on a research project titled “Capturing Hurricane Katrina Data for Analysis and Lessons-Learned Research.” The goal of this project is to develop a national resource that describes the advantages and shortcomings of the applications of geospatial technology during Hurricane Katrina. The outcome of this project will serve as a valuable resource for administering improved efficiency in data access and communication during future hurricane seasons. The objectives of my research were to: a) determine the extent of open research on geospatial technology and the similarity of that research to our project, and b) compare and contrast the applications of geospatial information in emergency response experienced during Katrina to international disasters. The available research on the usage of geospatial technology during a hurricane will show the extent of geospatial technology applications in the disaster management community.

The method used to produce these findings was Piranha©, a software that parses large amounts of text data and extracts keywords and themes. The results showed that 21% of documents contained information about geospatial technology during a hurricane response. However, only 4% of documents contained information similar to our project goal. These statistics indicate the need for increased awareness about the role geospatial technology can have during emergency response. More extensive research was performed to contrast the use of geospatial technology during Katrina to international disasters. Although much information on lessons-learned from Katrina can be found, very little about how geospatial technology was implemented is available. Instead, I gleaned information from various interviews with people who worked with geospatial response teams in Louisiana and Mississippi. The interviews showed that there was a strong need for geospatial information, however, dispersed data was difficult to access and the lack of preparedness made it hard to efficiently set up geospatial response centers. The international disaster case studies demonstrate that many countries are achieving advancements in the development of ways to centralize data, and receiving useful support from international institutions.
These case studies provide a wealth knowledge that can be applied to the lessons learned during Hurricane Katrina.
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Geospatial Technology Overview

“If a picture is worth a thousand words, a map can be worth even more.”
Francesco Pisano, UNITAR

Geospatial technology is used for the collection, analysis and visualization of geographic information. In an emergency, up-to-date information is needed for coordination, communication and efficient decision making. During a disaster geospatial technology integrates diverse and disparate data and makes it accessible. Geospatial technology can provide time critical information to responders and decision makers, and provide powerful visualization in coordinating disaster preparedness, response and recovery efforts.

During Hurricane Katrina 70% of the police force in New Orleans were victims, leaving the city with limited law enforcement. Officers from other areas were called in who were not familiar with the city. Geospatial technology was used to create maps that included roads and major infrastructure locations to help guide first responders coming from different areas. Information on things such as water supplies, electricity outages and baseball fields to land helicopters was needed, and supplied to first responders by the use of geospatial technology.

Although geospatial technology may seem like the perfect solution to bolster communication and decision making efficiency, it has many complications. During a disaster all levels of government actively work. Most datasets are from different sources and different levels of government. GIS (geographic information system) response centers in Louisiana and Mississippi during Katrina were “ad-hoc” and little preparation was put into gathering resources such as computers and plotters. Time that could have been spent supporting relief efforts was lost because of lack of preparedness.

After much miscommunication during Katrina, it was apparent that access to centralized data on all levels of government is important. A major disaster typically affects more than one local city. A centralized geospatial database is one way of storing and accessing the data that exists between multiple sources and levels of government. However, there are many implications that go into establishing this architecture such as,

- Role each level of government would have in development
- Shared standards and
- Lack of funding
Lack of standards, data access and resources hinders the ability to create a fully interoperable and dynamic system. As technology improves, geospatial technology is able to supply more immediate information, consequently creating better efficiency in emergency response.
Project Task

Oak Ridge National Laboratory (ORNL) in conjunction with Mississippi State University is working on a project titled “Capturing Hurricane Katrina Data for Analysis and Lessons-Learned Research.” The goal of this project is to develop a national resource that describes the advantages and shortcomings of the applications of geospatial technology during Hurricane Katrina. The outcome of this project will serve as a valuable resource for administering improved efficiency in data access and communication during future hurricane seasons. The objectives of my research were to: a) determine the extent of open research on geospatial technology and the similarity of that research to our project, and b) compare and contrast the applications of geospatial information in emergency response experienced during Katrina to international disasters.

The first component of my research was to see to what extent is geospatial technology used in the disaster management community. Using Piranha©, software developed at ORNL, keywords and themes can quickly be extracted from a large set of text documents. This tool was also used to find what open research contains information similar to our project research.

If one end goal of the project is to improve the use of geospatial technology for future hurricane seasons, it is necessary to look at its inadequacies during Katrina. Researching how GIS was managed during Katrina is needed to pull out what issues are being learned. The purpose of extracting key issues that came out of Katrina is to find examples of how these issues have been overcome in other disasters. Disasters, such as the Indian Ocean Tsunami, occurred on a much larger scale than Hurricane Katrina but emergency response was reported as more successful. Countries, such as Belgium and Sri Lanka, have taken steps to develop centralized geospatial data stores to be used in the case of an emergency. Looking at how geospatial technology is being applied internationally can offer ideas on how to improve efforts domestically.
Extent of Geospatial Technology Application

In the aftermath of a major disaster, hundreds of articles are published on the successes and shortcomings of how it was managed. Many lessons have been learned, but which of these includes geospatial technology? My objective was to find the available research on the usage of geospatial technology during a hurricane in order to show the extent of geospatial technology applications in the disaster management community. This information was also helpful in finding what open research exists that is similar to our project.

The method used to produce these findings was Piranha©, a software that parses large amounts of text data and extracts keywords and themes. 18 different search terms were used to collect 106 documents related to topics such as information, communication and geospatial technology during a hurricane (see Appendix A for the full search term list). This collection represents a subset of what general data is public knowledge. The collection was analyzed in three different ways: 1) cluster comparisons, 2) sub category clusters and 3) project similarity.

Cluster Comparisons
A cluster is a collection of words that describe one central topic. The different topics that were created were

- **information** = [information, share, data, communication, interoperability, system, collection]
- **geospatial technology** = [gis, geospatial, map, satellite, imagery, gps, geographical]
- **hurricane** = [hurricane, flood, water, emergency, disaster]
- **both** (GIS and information combined)

Each topic was created from a different cluster of related words. Searching the collection of documents against a cluster of words was useful to pull out main themes. It was easy to see if the set of documents were more related to hurricanes, geospatial technology or general information. The chart below breaks down the results.
The majority of documents (79%) did not incorporate information about geospatial technology. Although 21% did, it is still an indication that there is a need to increase awareness about the capacity geospatial technology can have during all phases of disaster management.

**Sub Categories Cluster Search**
Within the collection of documents, documents related to key themes such as

- National Response Plan (NRP)
- Standards,
- FEMA
- Interoperability
- Response

were pulled out into separate categories. The objective was to find how apparent geospatial technology is within each of these sub-categories. The documents in each sub-category were compared against clusters of words related to geospatial technology and general information sharing. Surprisingly, very few documents in each category contained any information about geospatial technology or GIS.
Project Similarity

Piranha was used to compare the gathered data to our project document. This data could serve as a helpful resource about what other organizations are working on similar projects and what data they have acquired. In Piranha, thresholds are used to find which documents are most similar to the search criteria. A threshold between 0 and 1 (1 being an exact match) is set depending on how accurate of a comparison is desired. For the purposes of this experiment a threshold of 0.5 was used. At this threshold 3.8% of the collected documents were similar to our project document.

All of these documents are from different sources. From this research one document called “Hurricane Katrina: GIS Response for a Major Metropolitan Area” provided insight into what research similar to ours is being conducted in Louisiana. Although this document is beneficial, the vast majority of documents do
not contain research similar to our project. This further confirms that our project will be a useful national resource for the disaster management community.
Case Studies

A knowledge set of lessons-learned was produced from case studies on international institutions using geospatial technology and different international disasters. The book “Geo-information for Disaster Management” was the predominant resource in finding this information. Further information was extracted from various websites sources.

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Australia

Australia is composed of one federal government, eight state/territory governments and about 700 municipalities. The wake of various catastrophic disasters has generated greater concern for a more strategic approach to emergency management. In August 2002, the Council of Australian Governments (COAG) released a report concerning the reformation on natural disaster response.

Many reform commitments were identified including:

- Reform Commitment 1: Develop and implement a five-year national program of systematic and rigorous disaster risk assessments
- Reform Commitment 2 - Establish a nationally consistent system of data collection, research and analysis to ensure a sound knowledge base on natural disasters and disaster mitigation.

In 2003, the Australian & New Zealand Land Information Council (ANZLIC) recommended the creation of a national Distributed Spatial Data Library. ANZLIC pushed on with its plans although past attempts to create a centralized system have failed due to the lack of resources needed to manage it.

The creation of a national spatial library is becoming increasingly accepted on the state/territory level, but it faces more resistance on the federal level. However, the combination of both a bottom-up (state/territory) and top down (federal) approach is necessary because either one is unlikely to work on its own.

Once ANZLIC recognized the need for a centralized framework, Geoscience Australia’s Risk Research Group worked on creating a prototype of an "All-Hazards" data model to create discussion. The "All-Hazards" approach was used because whether man-made or natural, the base data sets needed for emergency response are similar. Also, the organizations that respond to a disaster are often the same no matter what kind of disaster occurs.

During the creation of the "All-Hazards" data model, ANZLIC worked with the Emergency Management Information Development Plan (EM IMP) and the Emergency Management Spatial Information Network Australia to share results and solicit feedback from members of the emergency management community. Many organizations are unaware of the potential GIS technology has. This potential was demonstrated in Australia through 24 nationwide workshops by the "GeoInsight" program in 2002. At these workshops GIS delivery of information was demonstrated for all phases of emergency management.
In Australia it has been found that the drive for change is usually found in the jurisdictions that have experience large-scale disasters. During the 2003 bushfires in Canberra an ad-hoc GIS facility was set up by volunteers. The ad-hoc nature shows its inadequacies in integrating GIS into emergency management. The information could have also been used in all phases of disaster management. The fires were also a part of other jurisdictions. However, services were not easily coordinated across different political boundaries. This has lead to closer coordination of services between ACT and NSW. Although many jurisdictions are utilizing GIS more, they are using different software and are at different stages of development and implementation. This shows the continuing need for a centralized, cohesive spatial library.

There are many difficulties involved in convincing organizations to share information. One reason is because of the intellectual property rights involved. It is easier amongst smaller territories to share information than larger jurisdictions. Many organizations worry that sharing information will cause them to lose the operational control of their business. It is important to show these organizations how sharing data will help them become more productive. Both technical and cultural barriers exist as well. The management of IP and security over the web as well as the lack of standardization over symbology are technical barriers. Culture barriers, notably the hardest problem, come when organizations are resistant to share their information with other jurisdictions.

In Australia leading organizations are using their influence in the emergency management community. The Australian Emergency Management Committee (AEMC) endorsed major recommendations in the COAG report on reforming emergency management for natural disasters in Australia. It also recognizes that state/territories can't cope with major disasters. There needs to be a national framework that can assist as well. A distributed spatial library is a tool that once implemented could help with communication across all levels of organizations.

-----------------------------------------------

Lesson Learned:
All levels of government must be made aware of the capacity GIS has for emergency response. A centralized GIS database that takes an “All-Hazards” approach is the best way to serve many different disaster scenarios.

Australia faces similar barriers to the US when developing effective emergency management. Both the US and Australia have to deal with improving communication over three levels of government. However, Australia has identified the potential value and taken many steps to advance the creation of a centralized spatial library. Although the Hurricane Katrina & Rita Clearinghouse Cooperative was created after Katrina, a centralized All-Hazards system does not exist. The All-
Hazards approach should be used because it is a single resource that can service many different disasters. Bouquet

The Australian & New Zealand Land Information Council (ANZLIC) recognized that in order for the governments to accept a centralized GIS, it needed to raise awareness on all levels of government. Feedback sessions and workshops were used to spread information and improve the All-Hazards model. Australia faced many of the same concerns (lack of resource management, resistance on the federal level, intellectual property rights, insufficient awareness and different standards) as the US is facing now. If a centralized system in the US is to be implemented, a working model has to be created and then campaigned to major leaders in the emergency and disaster management community.
Belgium

In 1988 the Federal Crisis Centre in Belgium was created after a series of disastrous events in the 80’s. The Crisis Centre is composed of 60 employees who work 24/7. The Crisis Centre offers:

- powerful computers
- telecommunication networks
- documentation centre
- databases
- GIS and video-conferencing

The Crisis Centre was first used to provide mapping to help decision makers. Since then it has improved and now has a goal set on standardizing and integrating critical data sets into one regularly updated system. The system is managed solely by the Crisis Centre and has customizable functions for its own mapping needs. The Crisis Centre also had partnerships set up to help with data exchange between different bodies. It maintains updated reference maps, efficient geocoding procedures that turn raw data into useable geo-information and GIS tools to maintain the ability to perform geographical data analysis.

Case Study: On July 30th, 2005 a massive gas explosion at Ghislenghien, Belgium killed 24 people. The pipeline exploded after a leak of pressurized gas. Although there was very technical information about the pipelines, there was no map/database of existing pipelines throughout the entire country. The Crisis Centre collected data and created a map with the necessary attributes. The Crisis Centre was the head of this project but data was also collected from different Federal organizations. Fire brigades and civil protection units still use these maps.


Lesson Learned:

*Have GIS resources and technology at hand and organized before a disaster occurs.*

The Crisis Centre in Belgium demonstrates the usefulness of a centralized center devoted towards providing geospatial information during a crisis. During Katrina
the GIS response centers in Louisiana and Mississippi were “ad-hoc” and lacked resources such as computers, plotters and internet capacity. The Crisis Centre, which serves national and local authorities, already has the appropriate resources and technology at hand before a disaster occurs.
Brandenburg, Germany

One of the ongoing challenges with disaster management is communication between different layers of the government with NGO’s and citizens involved in the disaster. In the sphere of GIS technology it is becoming increasingly more important to create standards for access and sharing of spatial data. This data must be accessible and useful during a crisis for emergency responders to use. With the international standardization of data and services, it will become easier to share information more efficiently.

The Spatial Data Infrastructure (SDI) is the base collection of technologies, policies, and institutional arrangements that facilitate the availability of and access to spatial data. The SDI gives the basis spatial data for all levels of government, NGOs and citizens. In Germany most data is help privately and not between different organizations. This makes it difficult for the user when the data needed is found in different levels of government as well as the community.

In Brandenburg, Germany the Geodaten-Infrastruktur Brandenburg was created to employ the Brandenburg SDI. A workshop focused on disaster management brought together people from the Ministry of Interior, communities’ disaster management, GIS experts, data and software supplies and local research institutions. The discussion noted that accessing spatial data is complicated and data sources are often unknown. There was also a lack of dispatching management, which is aided by poor communication by local emergency management operations. The use of a standardized web service that provides data to the public was also noted as something essential for complex disaster scenarios.

A specific Disaster Management group was created and established these goals:
- Detect existing gaps in disaster management
- Standardize procedures and data for information management
- Cooperate with scientific research and neighboring areas to improve information exchange, flexibility and interoperability.

Lesson Learned:
Standards need to be developed by all key players in the emergency and disaster management community.
The Spatial Data Infrastructure is not new to the US. In fact the Federal Geographic Data Committee is very active with it. Just like Brandenbury, the US is aware of the SDI and what it means. However, Brandenburg brought together all key players in the emergency management community to look at what improvements need to be made to the Brandenburg SDI. The output of this workshop was a Disaster Management group with specific goals. The US needs to collaborate together and look at how the SDI standards are implemented during an emergency at all levels of government.
Indian Ocean Tsunami

Overview of the Tsunami
On December 26th an earthquake, measuring 9.0 on the Richter scale, off the western coast of Sumatra propagated a series of devastating tsunamis. The waves, reaching up to 30m in height, crashed upon the countries of India, Indonesia, Kenya, Malaysia, Maldives, Myanmar, Seychelles, Somalia, Sri Lanka, Thailand, and the United Republic of Tanzania. The numbers vary amongst different sources but approximately 280,000 people were killed and 2 million displaced. This disaster of unseen proportions triggered a vast amount of humanitarian relief instantly.

General and GIS specific resources
Relief poured in from federal, NGO and private organizations. According to ReliefWeb the total amount of monetary relief received thus far is $6.2 billion in international relief and $575 million in uncommitted pledges. It was not so much a struggle to find financial backing than it was to organize the hundreds of humanitarian organizations that immediately inundated the area.

Although technology may be the last thought on a responders mind, it is vital in a complex situation to coordinate the large amounts of information. Without that coordination, loss of time and duplication of data occurs, which in an emergency will costs lives. Many international organizations, specifically those within the UN, worked hard to provide geospatial information to realize the extent of the disaster as well as support relief efforts.

The UN OCHA was given the task to provide support and guidance for relief workers and also to disseminate information globally for the international community. OCHA set up two Humanitarian Information Centers (HIC) in Sumatra and Sri Lanka. Both centers used GIS to produce maps for information such as injured populations, damage assessments and internally displaced persons (IDPs). In effort to improve logistic potential of humanitarian organizations, UN Joint Logistics Center (UNJLC) worked with the Veterans of Vietnam in America Foundation to produce an atlas of damaged or destroyed bridges in Sumatra. Other organizations that provided geospatial technical assistance included:

- Food and Agriculture Organization of the United Nations
- United Nations Children's Fund (UNICEF)
- United Nations High Commissioner for Refugees
- United Nations World Food Programme
- UNOSAT
- World Health Organization (WHO)

The United States provided a great amount of assistance in the aftermath of the tsunami. The National Oceanic and Atmospheric Administration (NOAA) was the first to release public animations of the tsunami. This helped raise awareness in the public as well to responders on the extent of the disaster. USAID also produced
maps of the affected countries and which US government programs were associated with each. The USGS posted mapping information at http://gisdata.usgs.gov/website/tsunami/. This was another source valuable to the public and humanitarian organizations.

The Pacific Disaster Center (PDC), whose mission is to improve disaster management and humanitarian support in the Asian Pacific region, was able to quickly circulate valuable data and imagery to the global community. One of the projects the PDC quickly created was the deployment of an ArcIMS software-based Map Viewer. The Map Viewer displays “Landsat imagery, Shuttle Radar Topography, mission-derived shaded relief images, LandScan population density, detailed coastlines, damaged polygons and high-resolution imagery received from the U.S. government's Commercial Satellite Imagery Library.” In order to aid PDC, ESRI sent technical staff to keep up availability of these resources.

The Geospatial One-Stop at geodata.gov was used to produce maps and organize data sources. This was a good place for volunteer organizations, local GIS companies and international organizations to provide support. MapAction, a NGO in the UK, provided mapping to Sri Lanka in forms of land mine hazards, damaged bridges, damaged schools and camp locations of internally displaced persons.

ESRI provided much support to the disaster. ESRI Thailand used ArcGIS and produced an atlas of the affected area. Search and rescue then used this atlas to survey the damaged area. Findings from the S&R teams were also put into a daily situation map to update various organizations such as highway and telephone companies. ESRI Thailand used video mapping technology to help response teams estimate damage over large areas. ESRI Thailand also published information for places in Thailand affected by the tsunami. ESRI Sri Lanka, ESRI Australia, ESRI South Asia and ESRI India contributed to tsunami response. ESRI Switzerland, Italia, Sweden and UK provided relief by supporting organizations in their region.

The above organizations played major roles in providing GIS support to humanitarian relief during the tsunami. However, there are many other organizations that have helped with providing geospatial information. David Gadsden from ESRI sums up the importance GIS plays in an emergency: “GIS provides an invaluable framework for building an information base and providing the best decision support, communication, and collaboration possible.”

During the Indian Ocean Tsunami, geospatial data was largely distributed online. The Internet is a valuable system to share knowledge on because it makes information widely available at no cost. It quickly became the main source of information for geospatial technology. Reliefweb, AlertNet, the UNOSAT web portal and the websites for the HICs were some tools that were able to share information immediately after the tsunami hit. On ReliefWeb hundreds of articles containing updates were posted on December 26. The first map published by BBC on ReliefWeb was put out on December 26 and showed the extent of the potentially affected areas. Computers were donated to different locations by IBM and USAID. Most humanitarian organizations used some sort of GIS data. A few examples of those organizations that used GIS in their relief efforts are:
Another mechanism to retrieve space imagery at no cost is by invoking the International Charter. The UN can do this through the UN Office for Outer Space Affairs (UN OOSA). Prompt action was taken immediately after the tsunami to gather geospatial data. Below is an example of the productivity in getting data.

Examples from ReliefWeb

ReliefWeb is an online resource for the latest information on emergencies around the world. It contains information on latest updates, appeals & funding, maps, who's working, country profile and more. It is a tool that should be well known during a disaster. Below are some examples of maps that were produced during the tsunami.
Figure 1: Updated articles and maps

Figure 2: Map of Indonesia, issued the day of the tsunami
Problems and GIS for the future

Although the use of GIS was prevalent and important during the tsunami, problems still existed. Disasters affect both economic and social sphere. Most of the countries the tsunami affected are poor and prior data was lacking that would have been useful in creating maps more efficiently. Another problem was the duplication of data. Without communication between humanitarian organizations there is no way to know if another organization has already produced that data. As seen in Hurricane Katrina, bureaucracy is another barrier in time and data productivity. Political ramifications make access to data difficult.

GIS technology is a critical tool to be used during disaster relief. A centralized geospatial database is needed when responding to such a large scale disaster. All people invested into relief, from NGO to government organizations, need to be aware of the GIS tools available. As seen during the tsunami, financial backing was sufficient, but poor coordination made everything more difficult. Coordination lacked because of the different levels of information. Therefore a central system that organizes information for these disparate levels would aim to create more efficient response that will save more lives.

Lesson Learned:

Geospatial information from international institutions and open-source web sources are valuable to know prior to a disaster and an important component to successful relief.

Although disaster response to the Indian Ocean Tsunami was not perfect, it was considered more successful than many disasters in the past. The outpouring of international relief provided the afflicted countries with millions of dollars in humanitarian relief. Since the tsunami happened on such a large scale, geospatial data was very important in realizing the extent of the disaster and where to cover response. Many international organizations such as UNOSAT and the WFP provided GIS assistance. Many other organizations like Mercy Corps and Sarvodaya used the geospatial information. Online organizations also contributed free geospatial information to the public.
International Space Charter

“Following the UNISPACE III conference held in Vienna, Austria in July 1999, the European and French space agencies (ESA and CNES) initiated the International Charter "Space and Major Disasters", with the Canadian Space Agency (CSA) signing the Charter on October 20, 2000. In September of 2001, the National Oceanic and Atmospheric Administration (NOAA) and the Indian Space Research Organization (ISRO) also became members of the Charter. The Argentine Space Agency (CONAE) joined in July 2003. The Japan Aerospace Exploration Agency (JAXA) became a member in February 2005. The United States Geological Survey (USGS) has also joined the Charter as part of the U.S. team. BNSC/DMC became a member in November 2005. The China National Space Administration (CNSA) joined in May 2007 (International Charter, 1).”

The Charter is set up to provide authorized users with satellite imagery of natural or man-made disasters. A Project Manager is used to explain the needs of the user to the appropriate contacts so that imagery and analysis can be retrieved.

In developing countries the perception is that satellite imagery is very expensive. Most countries do not have knowledge that the Charter exists nor that they have access to free satellite imagery. Examples of how the Charter has made an impact:
On August 5th, the DFD-ZKI (part of the German Remote Sensing Data Center) was the project manager for a request for activation by the Portuguese fire brigade. In 18 days the Charter delivered 52 satellite images as correctly adjusted geo data sets.

The Charter supplied the first damage analysis maps to Bam, Iran when it was struck by a severe earthquake.

In Afghanistan, natural disasters have killed an estimated 19,000 people and displaced 7.5 million. Floods and landslides have contributed to the deaths and displacement of thousands. Since the Afghanistan government is weak, it depends on both the UN and humanitarian efforts to respond to a disaster. In March 2002, satellite imagery was first used in Afghanistan after an earthquake occurred killing 1000 people.

In order to have field workers, NGOs and other relief agencies accept and understand the importance of spatial information for decision making, training is a necessity.

Lesson Learned:
The International Charter should be utilized during a large-scale disaster because it provides satellite-imagery that is a) free and b) can give quick insight on the extent of the disaster.

The International Charter for Space and Major Disasters provides free satellite imagery during a major disaster. It is a resource highly valuable for developing countries that do not have the funds to get satellite imagery. In a large-scale disaster satellite imagery is very useful in providing information about the extent of the disaster. The Charter is a valuable resource that should be used when needed.
DataLand is an initiative in The Netherlands whose mission to make geographical information widely accessible and centralized. Instead of keeping the geographical information localized within municipalities, DataLand makes disaster management turn regional. However, it did face many challenges before its implementation. The Netherlands is comprised of many municipalities that all individually contain data in different formats. Also, in the attempt to central data, DataLand had to figure out who would own the data, who would manage it and ensure quality.

The technical problems were not from developing the system but rather inputting all of the dispersed data forms. DataLand used the standard tax exchange form and a combination of metadata that reveals which standards and where the source of information came from to help solve the technical problems.

An experiment in 2003 was conducted to pilot DataLand. It was able to be utilized during a gas explosion on the border of two municipalities. Without the help of DataLand access to information would have much more difficult. Using DataLand the response time was decreased. DataLand shows how there can be cooperation between municipalities and other disaster organizations through one central distribution area.


**Lesson Learned**

*In order to foster better communication and coordination during an emergency, data from local governments should be integrated into one centralized geospatial database.*

The DataLand initiative brought together scattered data from over many municipalities into one centralized geospatial database. This was not an easy task as data was in different formats. Before creating the database structure, many questions had to be answered about the propriety of the database and who would be in charge. However, endeavors pressed on and DataLand was created. Shortly after its creation, its value was shown when it was used to foster better cooperation between municipalities during a gas explosion disasters.
Sri Lanka

Sahana: Free and Open Source Disaster Management System

“Help alleviate human suffering and help save lives through the efficient use of IT during a disaster”

In the midst of a large-scale disaster both the rich and poor nations struggle to handle the influx of relief resources. Lack of coordination between different levels of government, NGOs, volunteer organizations and citizens propagates the chaotic atmosphere. Generally the use of technology is overlooked as more seemingly immediate needs are present. The thought of funding computers, GPS modules, etc. are passed over with other concerns. However, it is the use of information technology that can create an efficient relief effort. Lack of organization is not acceptable when human lives need to be saved.

Information and Communication Technology
The use of Information and Communication Technology (ICT) tools needs to be increased during an emergency. As have been seen in many cases during Hurricane Katrina and the Indian Ocean Tsunami, information and communication are critical to a successful response. Without it, resources are not allocated properly and time is spent poorly. Technology can be used as a tool to disperse information and improve communication. One technical tool that is often overlooked is geospatial technology. Geospatial technology can put maps in responder’s hands to point to places such as which areas are most affected, how many people are located in relief camps, and where volunteer organizations are.

ICT and Geospatial Technology
If geospatial technology is such a useful tool then why does the disaster management community not embrace it? One reason is that geospatial technology is relatively new to disaster management and people are just starting to realize its potential. The attacks on the World Trade Centers was one of the first instances where to US government proactively used GIS. In developing nations, such as Sri Lanka and Indonesia, GIS is perceived as too expensive to implement. In many cases this could be true, however, with the Internet as well as open sourced software, access to geospatial data is available for little or no cost.

Introduction of Sahana
During the Indian Ocean Tsunami, it was evident that geographical information was needed but no prior GIS structure existed. A group of volunteers from the Sri Lankan IT industry began to build an open source disaster management system called Sahana. The main government in Sri Lanka deployed Sahana as part of its official portal just after three weeks. Sahana is a portable and adaptable system that can be downloaded for no cost. Since its creation Sahana has been deployed for the
Indian Ocean Tsunami, Pakistan Earthquake, Southern Leyte Mudslide Disaster, Yogjarkata Earthquake, and in humanitarian organizations such as Sarvodaya and Terres des Hommes.

**Detail on Sahana’s features**

Sahana has many features that increase efficiency during relief response. Below are the main features taken from the Sahana website:

- **Missing Person Registry** - Helping to reduce trauma by effectively finding missing persons
- **Organization Registry** - Coordinating and balancing the distribution of relief organizations in the affected areas and connecting relief groups allowing them to operate as one
- **Request Management System** - Registering and Tracking all incoming requests for support and relief up to fulfillment and helping donors connect to relief requirements
- **Camp Registry** - Tracking the location and numbers of victims in the various camps and temporary shelters setup all around the affected area
- **Volunteer Management** - Coordinate the contact info, skills, assignments and availability of volunteers and responders
- **Inventory Management** - Tracking the location, quantities, expiry of supplies stored for utilization in a disaster
- **Situation Awareness** - Providing a GIS overview of the situation at hand for the benefit of the decision makers

Geospatial technology is used to improve situational awareness. In the currently released version of Sahana geospatial information is used limitedly. However, in the next version it will be integrated further. Below is an interview from Mifan Careem who is leading the GIS work on Sahana.

**Chelsea:** How does Sahana use GIS?

**Mifan:** Currently, the latest alpha version of Sahana supports very basic level GIS: Allowing users to pinpoint locations of entities (camp, people) on maps, situational awareness where users can collaboratively enter information on locations, and location-based statistical reports. The current version uses Googlemaps as the backend, and is very limited in functionality.

**Chelsea:** Is geospatial technology going to be incorporated more into Sahana with up-to-date maps, etc.?

**Mifan:** Definitely. We are currently working on a distributed model for GIS in Sahana. Thus, the idea is to have a framework for GIS instead of a single module. The main goal here is to eliminate the limitation of requiring Sahana for GIS to
work: thus Sahana would be able to work with other GIS clients and server, where Sahana would also be able to act as a client or a server.

The next release of Sahana would consist of OpenLayers on the client side, and a local UMN/Mapserver on the server side, which are currently available in the testing version. Following the distributed model, the client will pick up data as WMS for the moment, even from the local server. All point information from the Sahana databases would be picked up as GeoRSS feeds. Thus as you can see, all this information originating from Sahana can be used by independent GIS as well.

The model we are following is wiki’d here: http://wiki.sahana.lk/doku.php?id=dev:gis_infra And a couple of modules mentioned there would be included in the next release.

Figure 1: Organization Report
Figure 2: Missing Person Registry

Figure 3: Use of geospatial technology
Figure 4: Organizational Registry

Figure 5: Request Registry

Conclusion
There are numerous NGO and federal agencies that have to work together to efficiently respond to an emergency. The open source community is one tool that can drastically change and improve relief efforts. It is difficult for the government to devote time and energy to disaster relief when they have other ongoing projects that need funding. However, it is necessary to have a system in place before the disaster strikes. During the Tsunami, the Sahana Disaster Management System was developed by an NGO in Sri Lanka. It quickly became part of the official portal for the main government in Sri Lanka. Since then it has been deployed in other major disasters. Sahana not only provides mapping but also various forums for missing people, resource allocation, etc. It is scalable and very portable. Sahana is a powerful tool that should be adopted not only NGOs but also the government. As geospatial technology is integrated into ICT tools, such as Sahana, responders will be able to administer aid more efficiently.

Lesson Learned

Existing tools, such as Sahana, should be used to develop a central, scalable, dynamic and interoperable system that operate in an open-source environment.

Sahana is a revolutionary tool in disaster management. From the start it was developed to handle any size disaster. Sahana incorporates GIS functionality and other organizational features. It was developed during the Indian Ocean Tsunami and quickly integrated into the emergency relief efforts in Sri Lanka. Since its implementation, Sahana has been a valuable tool in other major disasters. As the world seeks to consolidate information and create better communication during an emergency, Sahana is an example of a successful tool that can do just that.
Vietnam

Vietnam is often struck by periods of intense rainfall that leads to flooding. In the central areas millions of people without the financial means to evacuate are victims to this flooding. The Vietnamese Disaster Management Unit (DMU) is in charge of preparing and responding to a disaster. There are various known problems that exist within the disaster management, such as there are no flash flood warnings and spatial data is carried out in government institutions and universities rather than on the emergency field or in remote areas. The DMU has acknowledged that flood preparedness is needed and that spatial data and effective mapping is needed to improve emergency management. Public knowledge of historic flooding as well as training on the integration of GIS technology is important to improve preparedness and response.

Vulnerability Analysis (VA) is another important step in preparing for a disaster. VA is research that will define “the links in a chain of (mostly uncontrolled and/or unwanted) processes through which an external hazard is affecting ourselves and/or our environment.” It is important to conduct a VA because in an disaster, such as flooding, it can bring forth the areas at most risk. This can better prepare the government and other organizations when responding to flooding.


Lesson Learned

Disaster management is not just response. Preparedness is crucial.
California

The Mountain Area Safety Taskforce (MAST) is an excellent example of how disaster management agencies can use GIS to work together and prepare for a disaster. MAST was first created to analyze the risks of fires in California. MAST is comprised of:

- federal
- state
- county
- local
- volunteer
- and private organizations.

MAST created a Memorandum of Understanding (MOU) which helped in resolving communication problems between different agencies. One database was shared throughout the agencies and it “was developed for modeling, analysis, resource management and response planning.” ESRI assisted MAST with GIS support as well as hosted their public website (www.calmast.org). Often data came in various formats and there was not enough metadata attached. The MAST database manager worked hard to put the data into common formats and track down any missing data.

The MAST centralized database proved to be very effective during the 2003 Southern California fires. Law enforcement personnel already had preplanned evacuation routes and who would be in charge of these evacuations. Much confusion was eliminated because of the efforts put into having prepared information for emergency responders. Maps were important in conducting updated action plans every 12 hours. Leaders and fire fighters were distributed GIS map books that helped those from outside the local area assist. 3D images were valuable in displaying the overall progress of events during briefings. Mobile devices were used by fire fighters and the data was downloaded to the GIS database.

---------------------------------------------------------------------

Lessons Learned:
Prepare geospatial databases and communication structures before a threat is imminent.

The main lesson that should be learned is preparedness. MAST identified a risk and immediately started to prepare for what might occur. The Memorandum of Understanding can be compared to the National Incident Management System that FEMA uses. The NIMS was not fully implemented before Katrina hit, so that communication structure was not used. The NIMS should also contain a section that outlines how geospatial data will be shared and accessed during an emergency.

MAST worked hard to develop a centralized geospatial database before a fire occurred. This proved useful when much confusion was eliminated during the 2003 Southern California fires because steps had been taken to prepare for that disaster. The US EM community needs to see the value in being prepared with geospatial databases and communication structures before a disaster hits. It is not enough to start preparing once the threat is imminent.
New York City

GIS technology was not utilized in the U.S. very much prior to 9/11. During the 9/11 emergency GIS was implemented. An EOC had to be setup temporarily at the Police Training Academy because GIS Utility Office was only one block from the World Trade Centers. Many lessons were learned in the process of developing on-the-fly GIS information. The lessons listed below come from the article cited.

**General Lessons**
- be prepared
- recognize the life and death nature of the emergency
- incorporate GIS and geo-information technologies within emergency plans
- maintain off-site backup of data and resources
- recognize the impact of heightened security on disaster operations
- plan disaster operations to be as close to normal procedures as practical

**Operational Lessons**
- paper maps are in demand and cause production bottlenecks
- pre-define standard products
- data and product quality assurance is critical
- logistical support and management are important
- anticipate future needs as the event evolves.

**Organizational Lessons**
- provide strong geo-information leadership during a disaster
- assign geo-information expert persons or unit for 24/7 emergency operations
- provide disaster managers and personnel with appropriate training in the use of GIS
- recognize distributed operations
Data Lessons

- prepare a comprehensive disaster support database of general-purpose and emergency-specific data
develop a robust data model designed for emergency purposes
- establish strong data-management and QA procedures to protect the integrity of the data
- provide a flexible capability to update and add data
design to data model to accommodate multiple levels of detail

Technical Lessons

- new technologies must be deployed prior to a disaster
- mobile wireless and location technologies offer potential but are vulnerable
- airborne/helicopter and other digital imagery have proven useful

Customer Lessons

- there is a large range of customer groups
- range of customer technical skills and needs
- accurate timely public information is important
- disaster response customers require maps with easily identifiable ground locations and orientation

Logistical Lessons

- distribution of information is critical
- the logistics must supply customers in many locations
- logistics are simplified by pre-determined of standard products and production capability
- paper distribution is necessary
- mobile GIS delivers go-information to responders in the field
- communication capabilities are particularly critical and vulnerable in a disaster

Lesson Learned

Incorporate existing lessons learned into a preparedness plan.
Conclusions

Many lessons can be learned by looking at how geospatial technology has been used to respond to international disasters. Four main lessons can be concluded from the case studies:

Centralized Geospatial System
- All levels of government must be made aware of the capacity GIS has for emergency response. A centralized GIS database that takes an “All-Hazards” approach is the best way to serve many different disaster scenarios.
- In order to foster better communication and coordination during an emergency, data from local governments should be integrated into one centralized geospatial database.
- Existing tools, such as Sahana, should be used to develop a central, scalable, dynamic and interoperable system that operates in an open-source environment.

Standards
- Standards need to be developed by all key players in the emergency management community.

Use of International Institutions
- GIS information from international institutions and open-source web sources are valuable to know prior to a disaster and an important component to successful relief.
- Although the International Charter may be more valuable to countries with no money for satellite-imagery, it should still be utilized during a large-scale disaster because it is a) free and b) can give quick insight on the extent of the disaster.

Preparedness
- Have GIS resources and technology at hand and organized before a disaster occurs.
- Disaster management is not just response. Preparedness is crucial.
- Prepare geospatial databases and communication structures before a threat is imminent.
- Incorporate existing lessons learned into a preparedness plan.
Applying International Case Studies to Hurricane Katrina

As seen from the Piranha data analysis, not much information is available about geospatial technology during Katrina. Three interviews with key personnel working in Mississippi and Louisiana helped gain insight into how GIS operations were run. See Appendix B for the interview questions and responses. From the interviews different issues emerged that affected GIS response negatively during Katrina. The issues were:

- Lack of resources
- Dispersed/Inaccessible Data
- Different Standards
- Ambiguous Communication
- No GIS Strategic Plan

Many of the international case studies bring forth examples of how these issues have been overcome.

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<tr>
<th>International Case Studies</th>
<th>Issues</th>
<th>International Case Studies</th>
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<tbody>
<tr>
<td>The Belgium Crisis Centre</td>
<td>Lack of Resources</td>
<td>The ANZLIC is developing a national &quot;All-Hazards&quot; Distributed Spatial Data Library.</td>
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<td>Belgium Crisis Centre</td>
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<td>The Netherlands DataLand</td>
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<tr>
<td>Workshops in Brandenburg,</td>
<td>Dispersed/Inaccessible Data</td>
<td>The Sahana software can be viewed simultaneously by multiple agencies to track aid requests, where organizations are working, missing persons and GIS information.</td>
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<td>Germany</td>
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<td>A specific Disaster Management group in Brandenburg, Germany was formed to detect existing gaps and improve information exchange.</td>
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<td></td>
<td>Different Standards</td>
<td>The The Belgium Crisis Centre has the resources and defined procedures to start providing information for emergency response immediately.</td>
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<td>MAST</td>
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<td>Vietnam Disaster Management Unit</td>
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Appendix A

Piranha Data Analysis

Search Terms (18):
- hurricane katrina data for analysis and lessons learned research
- hurricane katrina data lessons learned research
- hurricane katrina lessons learned research
- hurricane katrina data analysis
- katrina lessons learned
- hurricane katrina lessons analysis
- hurricane information sharing
- hurricane information systems
- hurricane communication lessons
- organizational communication hurricane
- natural disaster data management
- hurricane disaster data management
- hurricane response geospatial
- hurricane decision making
- hurricane geospatial
- hurricane preparedness
- geospatial decision making
- geospatial decision making hurricane
Appendix B

Interviews

*The information is not quoted directly, but rather notes written down as the interview occurred.

Dr. Richard B. Minnis: 2nd in command for GIS in Mississippi

Chelsea: When were the EOC (emergency operation centers) set up?

Dr. Minnis: MEMA set up a trailer in Jackson. There were two shifts of 10-12 ours each. Equipment was taken from all over the state, and it was hard to keep track of. Five teams of 2-3 people went out to different counties with a laptop and printer to work directly alongside emergency responders. The team was there for three weeks until FEMA came in. The military provided some IT help outside of the trailer.

Chelsea: Did we adequately prepare emergency scenarios before Katrina made landfall?

Dr, Minnis: No maps were created prior to Katrina’s landfall and photography was 9 years out of date. We were not prepared from a technology standpoint and everything was done on the fly. No potential scenarios were in place to setup and use GIS technology.

Chelsea: How could we have been more prepared?

Dr. Minnis: We could get more help from the government. The military had portable GIS units but we did not know. There needs to be better communication with FEMA about available resources. Preparedness scenarios and better technical facilities would have helped.

Chelsea: I’ve found that in cases such as the fire in Southern California in 2003, that having base maps in preparation for the disaster helps in evacuation and emergency response run more smoothly. Did we create maps prior to Katrina’s landfall?

Dr. Minnis: No maps were available. In general, GIS people are not being asked to contribute to emergency scenarios.

Chelsea: Where did the GIS volunteers come from?

Dr. Minnis: Almost all the workers were volunteers. One half came from MS and the other half from all over the US. Most of the volunteers were
knowledgeable in geospatial technology. Some of them were extremely knowledgeable. ESRI supplied 5-6 volunteers. One man was able to create a server so that everyone could work on the same data sets. They also supplied some laptops for the trailer.

**Chelsea:** What problems did emergency responders encounter when using GIS technology?

**Dr. Minnis:** There were limited computer and output capabilities. The computers were outdated and there was limited internet connectivity and power supply. Some availability of data sets was limited, and the government wanted to give 4 inch resolution photography but that is not usable for emergency response. The photographs were sent to MSU to be put in usable size, but there was a 7-8 day lag time.

**Chelsea:** What went smoothly?

**Dr. Minnis:** Road data sets were available and some other data sets were obtained from the MS Automated Resource System. Also, the state of Mississippi worked hard together.

**Chelsea:** Did we have GIS support from other countries and were we able to integrate it?

**Dr. Minnis:** There was not a lot of GIS support from other countries. Any maps created were not produced in time. More technical aid was needed then aid from the international community.

**Chelsea:** How much funding was there for GIS during hurricane Katrina?

**Dr. Minnis:** No funding was available at first. Once FEMA considered GIS the #1 monitoring system it provided some funding through MEMA. It was difficult to convince FEMA to spend $8,000 on paper and ink.

**Chelsea:** What types of information did you map?

**Dr. Minnis:** Water supplies, electricity outages, ice, hospitals, cell phone communications, baseball fields to land helicopters, road maps, tracking of where people moved during recovery, produced thousands of map books, which are helpful if GPS was not available, etc. Data that we did not have but was needed was information to track people and their pets, and to also find facilities that house pets.

**Chelsea:** In what ways did we receive help from the international community for mapping services?

**Dr. Minnis:** None.
Chelsea: I know all different organizations have different standards when using GIS technology. However, has there been an attempt to standardize and centralize this information?

Dr. Minnis: So far no. States like MS have the MARIS (Mississippi Automated Resource Information System) but some states do not. Having centralized GIS support centers for each state would be more valuable than regional centers. Standardized output was done on the fly (RAG maps).

Chelsea: What would improve the efficiency of GIS technology in future disasters?

Dr. Minnis: Set up preparedness scenarios and having a plan for setting up the GIS centers would help. Also, it would be valuable to have a team of knowledgeable people in GIS to be on call for volunteering during a disaster.

Chelsea: What would be the minimum requirements you would need for another similar emergency?

Dr. Minnis: We would need a newly functional lab system and a team of ready to go volunteers knowledgeable in GIS. The military helped out with the network, but having network capable people on the team would be helpful. The EOC in Jackson would need 10 GIS workstations, 3 plotters and other small outputs. The Forward EOC would need 2-3 people for each county, 2 computers, 1 plotter and 1 small output device. There should be a plan on how to set up make-shift labs and knowledge of where to get equipment (laptops, plotters, etc).
Chelsea: In what ways were you involved in GIS support during Katrina?
Doug: I worked in the research community doing mapping and modeling and worked through many flood claims.

Chelsea: How were operations set up in New Orleans?
Doug: FEMA has about 2,000 general employees. There needs to be more during a disaster. FEMA has about 1,000 reservists ready to go in an emergency. There is no full-time FEMA GIS employee. 20 employees help support GIS overall. Baton Rouge had a total of 100 people during Katrina

Chelsea: Was the LSU GIS Clearinghouse Cooperative (LGCC) put together before Katrina’s landfall?
Doug: The clearinghouse was made afterwards. Louisiana had no capabilities before the clearinghouse. Much of the equipment used was donated.

Chelsea: In what ways did FEMA supply support to these GIS facilities?
Doug: The government cannot take donated goods or services so the clearinghouse was needed. The government cannot hire non-US citizens but the clearinghouse could. The clearinghouse handed out maps on the field, not FEMA. FEMA helped setup tools to extract imagery. FEMA served more as a liaison and also accompanied LSU surveyors

Chelsea: Is GIS technology something FEMA is becoming more aware of as a useful tool in emergency response?
Doug: FEMA has to satisfy its programs first. It goes project to project and then it gets dropped, unfortunately this is the same in a disaster. Once they start to cut costs, they start to send people home. It is hard to retain good GIS staff in the reservists
Appendix B

Ron Langhelm - GIS spatial lead in Baton Rouge

Chelsea: What was your involvement during Katrina?
Ron: I was the GIS spatial lead and ran the office in Baton Rouge (40-50 people). Each state is managed differently. In MS they had the capabilities to use volunteers. FEMA cannot have volunteers because that system is not in place. In LA volunteers were not available like MS.

Chelsea: In your opinion, what ways could the use of GIS technology be improved when responding to a disaster?
Ron: Some problems that existed were internal FEMA issues, politics in LA, misunderstanding across local, state and federal authorities, and duplication of efforts. It took a long time to figure out the lead. FEMA primarily focused on search and rescue and in the third week they started to work on recovery. Many improvements can be made such as empower response with GIS, have data out immediately and ensure the capability of technology and resources before the disasters. There needs to be more GIS staff and FEMA should work out how to manage volunteers. GIS personnel from local and state authorities should support FEMA as volunteers.

Chelsea: Was the U.S. offered any assistance from international organizations?
Ron: No, nothing related to GIS.

Chelsea: What are the advantages and disadvantages of receiving international assistance (specifically related to GIS technology)?
Ron: It is difficult to receive. FEMA doesn’t have the means to make it part of the relief efforts. Also, political ramifications don’t support it.

Chelsea: I’ve found that it is hard for the government to support disaster preparedness because there are other higher priority projects that need funding. Do you think there is a way to change this and get FEMA to focus on disaster preparedness more?
Ron: One problem is that there are cultural differences between old and new school views. People who work in mitigation don’t see the use of the GIS tools available. Technology isn’t embraced. Mitigation and preparedness is generally done by local and state so FEMA cannot enforce it.
**Chelsea:** Was disaster management included in the preparedness section of the National Incident Management System (NIMS)?

**Ron:** It was in place, but in a fractured state. For example, there were 5 search and rescue teams that were not talking to each other. It also depends on state enforcement…if they don’t enforce it then FEMA cannot do much either. FEMA did use NIMS internally.