Parcel Data and Hurricane Isabel
A Case Study

Prepared for the FGDC Cadastral Subcommittee

by

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This case study is the product of a workshop that was organized by the Federal Geographic Data Committee's (FGDC) Subcommittee for Cadastral Data (Cadastral Subcommittee) and the Eastern States Cadastral Steering Committee with participants from local, state and federal agencies. Its purpose was to determine the utility of parcel data to emergency responders and the barriers to making this data available to them.

Introduction

Recent innovations in communication and Geographic Information Systems (GIS) technology has greatly improved the ability of emergency response agencies to prepare and react to hurricanes. On September 18, 2003, Hurricane Isabel made landfall on the Outer Banks of North Carolina. At the Army's Field Research Facility in Duck, North Carolina 100 miles north of where the eye cut across Hatteras Island, the Category 2 hurricane generated a five foot storm surge that

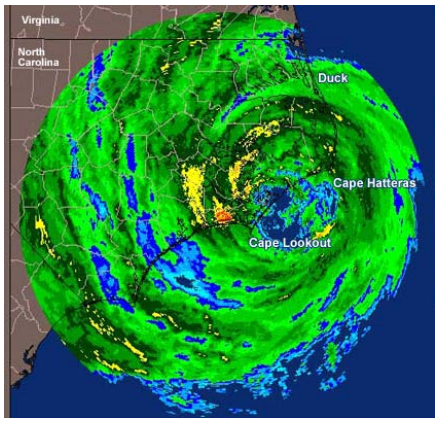

Figure 1: Radar Image of Hurricane

exceeded twenty seven years of measurements (http://coastal.er.usgs.gov/hurricanes/isabel/). One of the hardest hit areas was Hyde County North Carolina which alone sustained damages of more than 13 million dollars. The county was among those declared a major disaster area.[1]

The size and intensity of Hurricane Isabel had been tracked for two weeks and land fall was predicted far enough in advance to safely evacuate the communities that were in the path of the storm. Once Isabel had gone inland emergency response agencies were able to use GIS to integrate post storm aerial photography, rainfall measures and elevation data with the county's detailed digital maps of properties, structures, utilities and road networks. This information provided responders with a very powerful tool that allowed them to more effectively respond to flooding, power outages, debris removal, and the disbursement of emergency relief funds. Unfortunately this technology could not be fully utilized because local data was not always available in a digital format. Some communities that were directly in the path of the storm were unable to provide responders with data because they did not have the time to provide it to the state's GIS coordinating agency. Some of the more rural communities simply did not have data because they had neither the resources nor the expertise to convert their paper maps into a digital format

The Cadastral Subcommittee met in the fall of 2003 to identify situations where parcel data was needed to respond to natural disasters and to meet homeland security requirements. Many of the subcommittee representatives were from the Southeast and the focus of discussion became the

[1] Blake Harris, "Resurrecting the Court", Government Technology, March 2004, page 42-43

on-going recovery effort with Hurricane Isabel. As a result a workgroup was established that consisted of Eastern Cadastral Steering Committee members and Federal Emergency Management Agency (FEMA) staff in Atlanta. They tasked themselves to evaluate the utility of parcel data in an emergency response situation and to identify issues that limited access to local parcel databases. A one day facilitated workshop that was funded by the Bureau of Land Management (BLM) and the US Geological Survey (USGS) was held in late January 2004 in Raleigh, North Carolina with more than thirty federal, state, and local representatives that had been involved with Hurricane Isabel. Participants described events that they had experienced during the different phases of emergency response operations and the importance of parcel data to addressing their problems and issues.

WORKSHOP FINDINGS

It became immediately apparent that local governments had a wealth of digital GIS information that could be extremely beneficial to emergency responders. This data was available from over half of the affected counties and the accuracy and currency was much better than the Census data that FEMA has had to rely on. Many examples were given on how digital parcel information from local governments could improve the ability of FEMA and state agencies to respond to emergency situations. Input from the workshop participants was collected and compiled according to the five major stages of emergency operations: *Pre-Event, Response, Recovery, Mitigation, and Planning* (see Appendix A, Table 2).[2] Five specific findings were derived from the workshop.

Figure 2: A coastal area before and after the storm.

1) Parcel data provides intelligence to maps and imagery providing information about land ownership, property values, structures, and land use.

The workshop revealed that parcel data sets from local and county governments can provide essential detail about the land that serves emergency responders during all phases of an event. Knowledge of who owns the land, the value of improvements, current use, and the materials used in the construction of buildings is all essential information for emergency response staff in any disaster. Before the storm, when it became apparent that Isabel was going to strike the Outer Banks, participants from counties in the projected path reported that they were inundated with calls from homeowners and businesses concerned about their vulnerability to the potential storm surge. The counties that had digital parcel maps were able to quickly respond to these questions by overlaying the parcel data layer with elevation data identifying the threat to individual properties. After the storm had passed and the efforts moved from *Pre-Event and Response* to *Recovery,* parcel data was used to expedite relief to homeowners and business for both insurance claims and federal emergency loans. When assessors and insurance adjusters go into the field to make their damage assessments it takes some time to become oriented to a radically altered environment even for individuals that are familiar with the community (Figure 2). As a consequence it could require two and three trips

[2] Barabar Schauer, Earth Observation Magazine, "Hazus A Revolution in Rick Assessment" April/Map 2004 pages 4-9.

to a site to locate a property, acquire appropriate documentation, and then assess the damages. The counties that had digital parcel databases were able to provide the claims adjusters with GPS technology and portable databases that allowed them to confidently determine property

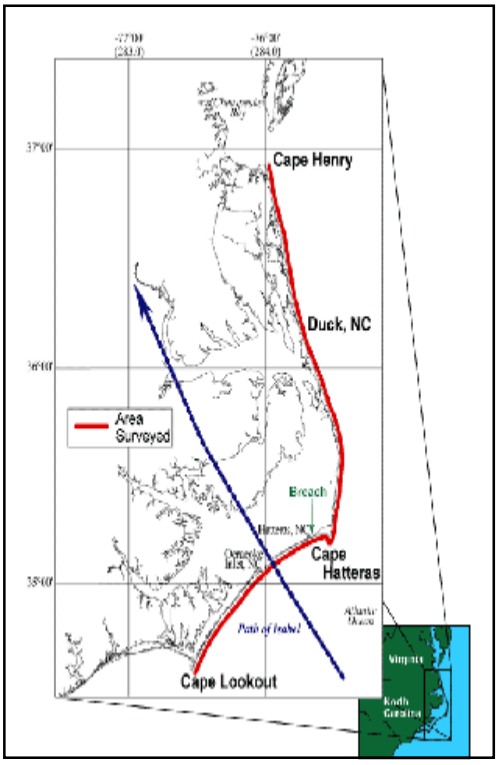

Figure 3: Hurricane Isabel's Path.

ownership and provided immediate access to all the information that they needed to assess the damage to a property. The assessment could be accomplished in one trip to the site greatly expediting the reporting process and the delivery of financial assistance to the property owners.

2) Integration of parcel data with other data sets and land characteristics provides a rich and stable data source.

A county parcel database typically has a six to ten foot horizontal accuracy providing the best spatial reference of the terrain. When these layers are integrated with aerial photography and other themes, locating critical infrastructure such as fire hydrants, water lines, parcel elevation, the nearest cross street, and other features can be found quickly and automatically. Time and again in the workshop participants identified the need to link information to a location based on human activities. A local county parcel database was the only data source that was able to meet those requirements. One of the more striking examples demonstrating the importance of parcel data integration occurred during the previous winter. Tracking power availability is one of the more critical monitoring activities during winter ice storms when the loss of heat can be fatal to the elderly and handicapped. Typically a utility company's electric networks are spatially tied to the transformer and not to the meters on the houses and as a consequence it is not possible to monitor whether individual properties had power or not. This was solved by linking the transformers customer list to the parcel database immediately providing a map of the status of individual residences.

3) Parcel data must be published in a format to meet national and local emergency response needs.

The workshop participants identified two critical requirements to efficiently integrate parcel data into emergency management regional databases. First, the county should publish a subset of their parcel database on an annual basis in a standard format that includes information needed by emergency responders. This subset of the county's data is termed the "core" data by the Cadastral Subcommittee.[3] Second, these published databases must be readily accessible off-site and provided to outside agencies in a structure that can be easily integrated with other published data sets. Because these conditions

[3] Cadastral Subcommittee, *Cadastral Core Data - Version 2,* FGDC Cadastral Subcommittee, 10/01/2001, Internet http://www.nationalcad.org/data/documents/CadCoreDataDraft.pdf

were not met during the early stages of *Response* and *Recovery*, emergency responders had to rely on ancillary databases that were much older and less accurate than what local government had in their databases. The Cadastral Subcommittee has proposed a draft core data standard to meet the needs of the National Map, but the "core" data elements that will best serve the emergency response community still needs to be defined and included as part of the standard.

4) The use of parcel information must be integrated into emergency response protocols.

Protocols used by FEMA are a set of rules and procedures that are followed in any emergency event. These "checklists" provide order and consistency during the chaotic events of an emergency ensuring that resources and materials are available when and where they are needed. During pre-event planning or in the aftermath of an emergency, the value of locally maintained parcel information is clear, but if this data is not a part of the protocol then the use of this valuable resource may be missed. Defining the standard and then adding collections of parcel information to FEMA protocols will provide the necessary lead time for counties to know how to package their information into a format that can be incorporated into the time critical response and recovery efforts. A notable example occurred in Onslow County, North Carolina, where staff had generated maps showing downed trees, affected structures, and areas of critical damage for their local response agencies. This information had to be regenerated into text-based tables for emergency response teams because the use of these maps was not part of the FEMA protocol.

5) Develop programs to promote parcel data automation and maintenance in less urban areas.

While North Carolina represents a stellar example of state-county cooperation in the development of land records programs and parcel automation, many of the less populated rural counties in other states have not begun land records modernization efforts because the resources are not available. The advantage to counties that have converted their parcel maps into digital form was dramatically demonstrated in the recovery phases for everything from the time it took to restore power to the processing of claims and the delivery of disaster relief funds.

A recent study has shown that approximately 60% of the parcels in the US are in a format that can be used in a GIS, but they are mostly in the more urban areas.[4] States that have parcel conversion programs that implement standards and assist with the conversion of parcel maps to digital formats have demonstrated great success in the more rural areas. Two examples bear witness to this claim. In 1998 Florida counties reported that forty-seven percent of the state's nine million parcels had been converted into a digital form. That year the Florida Department of Revenue began a program to assist the more rural counties with the conversion of paper maps into digital parcel databases. By 2004 over ninety percent of the state's parcels had been converted and the remainder are expected to be complete by 2006. The second example is Alabama, which is mostly rural compared to Florida. The Alabama Department of Revenue currently has a similar program under way and they have converted 75% of the state's parcels with complete coverage for 35 of their 67 counties. This is well above the national average of 60%.[5]

Other Observations and Examples of How Parcel Data was Used in an Emergency Situation

The participants in the workshop had many examples of how parcel databases were critical in

[4] Stage, David. *An Assessment of Parcel Data in the United States,* Surveying and Land Information Science, 2003, Vol. 63, No. 4, p. 235-241.
[5] Elrod, Allen. Alabama Department of Revenue, Eastern States Cadastral Forum, Atlanta, URISA, October 13, 2003

saving time, money and lives. The following are a few specific examples from the workshop that illustrate how important a digital parcel database can be.

Flooding: The most destructive force in a hurricane is the flooding that is caused by heavy rain fall. It is possible for areas to receive ten or more inches of rain in a 24 hour period. An incident occurred in North Carolina during Hurricane Fran in 1996. Enough rain had fallen that the Army Corps of Engineers determined that water needed to be released from North Carolina's Falls Lake Dam into the Neuse River. Time was critical and it was imperative that residents in the river basin were notified so they could be evacuated. Wake County was able to digitally overlay their parcel database with an elevation model of the area adjacent to the river identifying the homes that were in the most dangerous locations. Because residents could not be contacted due to power and phone outages, maps were printed that identified the homes at risk of flooding. These maps were given to Sheriff Deputies who were then able to go directly to the at risk homes to notify the occupants.

Agriculture and Aerial Spraying: After an event like Hurricane Isabel it is important to spray insecticides to reduce the dangers of diseases spread by mosquitoes to both humans and livestock. Typically this is airborne spraying with spray block planning based on post-event aerial photography to identify water retention areas. Aquaculture areas can be identified by visual inspection of aerial photography and where spraying concentrations are dangerous to the livestock, these areas can be avoided. However, organic farms can be easily overlooked in a visual inspection. If organic farms are included within the spray block or there is overspray from an adjoining block, the results can be economically devastating. A loss of organic farm certification will remain in effect for three years, significantly impacting the income of the farmer. A digital parcel database can be combined with imagery to provide the intelligence needed to assist in the identification sensitive crops and livestock.

Farm Animals: The care and feeding of farm animals after an event is another important consideration. Farm animal food supplies are often destroyed in a disaster and rapid response with large volumes of supplemental feed is essential for the survival of the livestock and the continued economic viability of the farm operation. Navigation to sites in rural communities can be difficult because of the loss of signage for local roads, loss of landmarks, and the lack of an addressing system for farm parcels. The representative from the North Carolina State Agriculture Office pointed out that most farmers regularly use and know the parcel identification number for their properties. Having the property number that is in a digital parcel database can assist with the routing of feed trucks to the sites and assure timely delivery of feed.

Human resources limits access to local government data in impacted counties: As demonstrated in Hurricane Andrew access to local data is limited by staffing of the local government information systems office. If this data has not already been prepared for publication it may not be accessible for several reasons.[6]

1. The number of staff that understand the computer systems, software, and programs that can deliver products are limited.

2. Staff that have the skills and knowledge to provide the necessary information to emergency responders live in the disaster area. At the same time they are most needed by the community they are also needed by their families.

[6] Local Preliminary Impact Assessment for Hurricane Andrew, Metro-Dade Geographic Information Center, Office of Computer Services, 1992 (unpublishded)

3. Staff that have expertise in using and accessing parcel data have physical limitations. This was demonstrated in Dade County, Florida in 1992 in the aftermath of Hurricane Andrew; those staff that could make it into their offices were only able to work for a limited time. After long shifts lasting twenty-four to thirty-six hours the flow of information stopped because staff were exhausted.

Backup Sites: There is a need for parcel data to be available from multiple sources. Serving parcel information with other data sets from distributed sites such as *The National Map*-NC/OneMap Project (http://www.nconemap.net) serves two needs: First it makes data available even when power outages or damage prevent local servers from providing the information; and secondly it optimizes distributed technology so that remote sites can harvest or mirror current information continuously rather than relying on periodic updates. Counties in the path of the hurricane were responding to immediate needs and struggling with power outages and system recovery. Redundant or back up sites allowed state and federal emergency staff to access the information they needed without putting additional workload on an already overloaded local staff.

Off-line Data: The data that is to be used in an emergency response environment must be published and available in secure mediums such as DVD's or portable hard drives in a "ready to go" format. During emergencies, communication networks are frequently disrupted and access to the networks is often unavailable. More importantly for security reasons access to web-based data sources are off limits in many emergency response control rooms. The threat of computer virus infections or corrupted data at critical moments can have disastrous consequences.

RECCOMENDATIONS

Digital parcel data is becoming readily available from more communities every year, particularly in areas with populations that are greater than 150,000. Obstacles to using and sharing digital parcel data are more often institutional in origin; an absence of data standards, the lack of appreciation for the utility parcel data, and the inadequacy of the infrastructure needed to compile the data into regional coverages were the most frequently cited problems. Issues related to files size, speed of access, integrating software and file transfers have all been fundamentally resolved. The workshop participants all agreed that there is great value in using locally maintained parcel data for emergency response operations because the information about landownership, structures and property values are current and accurate. Four recommendations that address these issues are presented below:

Recommendation 1: Establish Parcel Data Conversion Programs for Rural Counties:

Task 1: Identify and publish the best practices for programs that will assist rural counties in the conversion of the parcel maps into a digital format.

> *Responsibility:* FGDC Cadastral Subcommittee in association with the principle federal beneficiaries of an automated rural parcel data (BLM, FEMA, Census).

The conversion of parcel maps into a digital format is occurring in communities that have the tax revenue to support GIS services. Generally, rural counties of less than 50,000 are not able to initiate data conversion projects without outside funding or technical assistance. Several states in the Southeast have programs in place that provide technical support and cooperative funding to bring this technology into smaller communities. Hurricane Isabel demonstrated that

when disasters strike large areas many rural regions of the country may be caught short:

- The Census Bureau's data shows that metropolitan areas represent approximately 78% of the US population but only 20% of the land mass.[7]
- Sixteen of the twenty-six counties in the disaster area had less than 20,000 parcels.
- Only four counties in the disaster area provided data to the North Carolina corporate database before the 2003 hurricane season.

Funding of conversion from paper format to a standard digital format is achievable; cost range from $4.25 to $15.00 per parcel depending on the approach taken.[8] Experience with conversion assistance programs such as Florida's has shown that if these programs can ensure adherence to standards and access to data, regional governments are interested in contributing to cooperative funding programs.[9]

Recommendation 2: Include the use of Parcel Data in Emergency Response Protocols

Task 2: Determine the business requirements related to parcel data for the emergency responders in western states.

> *Responsibility:* FGDC Cadastral Subcommittee and the Eastern and Western Cadastral Steering Committees.

Task 3: Finalize a parcel core data standard that will define a publication data content standard for the nation.

> *Responsibility:* FGDC Cadastral Subcommittee and the Eastern and Western Cadastral Steering Committees.

The Hurricane Isabel Workshop identified the business requirements to address the needs that are specific to hurricanes as well as touching on a few other emergencies. Although the results of the workshop affect all of the Gulf and Eastern Seaboard we can not assume that these results accurately reflect the entire US for several reasons: 1) most natural disasters in the Western United States are wildfires and not hurricanes; 2) population density is much greater in the eastern states; and 3) BLM and the US Forest Service have a small presence in the eastern states although they are ubiquitous in the west. Finalizing core parcel data requirements for emergency responders and developing appropriate protocols for all emergency situations makes it necessary to acquire input on western state parcel data issues.

Task 4: Establish protocols to incorporate parcel data into emergency response operations.

> *Responsibility:* FEMA, FGDC Cadastral Subcommittee, and the Eastern and Western Cadastral Steering Committees

The emergency response protocol is a checklist of operational procedures that is followed during an emergency operation. To assure that parcel data is not an adhoc activity procedures and data formats need to be included in the protocols that will meet the entire spectrum of emergency response needs.

Recommendation 3: Identify Best Practices For Coordinating Parcel Information at the State Level.

Task 5: Complete a national inventory of how states centrally organize or manage statewide parcel data.

[7] US Census Bureau, GCT-P. Metropolitan Area Population by Size Class: 2000, Census 2000 Summary File 1 (SF 1) 100-Percent, Data. Online.Internet. September 2003. Available at http://www.census.gov
[8] Burgess, Bill. National States Geographic Information Council, US Mapping Cost Model, 2002
[9] Stage, David. Florida Department of Environmental Protection. Florida Department of Environmental Protection Cadastral Feasibility Study. 25 Sept. 2003.

Responsibility: FGDC Cadastral Subcommittee and the National States Geographic Information Council (NSGIC)

The creation of a seamless integrated statewide parcel database depends on the infrastructure that is available to centrally collect and organize this information. There are approximately 2,900 county and 1,500 municipal agencies responsible for managing and collecting parcel data for private lands in the US.[10] Federal agencies and tribal nations are also a significant source of parcel data, particularly in the western states. The status and methods that different states use to centrally organize, manage or compile parcel data is not well documented.

Recommendation 4: Identify and Document The Best Practices For Access to and Distribution of Parcel Data.

Task 6: Document the data stewardship responsibilities for parcel data management.

Responsibility: FGDC Cadastral Subcommittee task force on the Evaluation of the Cadastral NSDI.

Tasks 7: Document the best practices and methods for parcel data distribution.

Responsibility: USGS National Map, National States Geographic Information Council (NSGIC), and the FGDC Cadastral Subcommittee.

As previously mentioned there are over 4,400 entities that are responsible for collecting and managing parcel data at the county and municipal levels of government. The creation of regional parcel databases requires that an infrastructure is in place that can efficiently compile this data into regional or statewide data coverage. Current methods of access and distribution by the states include three principle approaches.

Compilation of independent databases: Counties manage the collection of their data locally adhering to guidelines provided by the state. Data is provided to a central collection agency according to standards promulgated by the coordinating agency. Typically the data is provided to the state revenue agency for reporting purposes of property assessment.

Centrally managed databases: A few states have centralized data creation, distribution and access systems, such as Montana and Tennessee. Data is compiled and managed at the state agency and then redistributed to the local units where it is used in locally managed applications and may be supplemented with locally generated information. The Montana service uses a centrally maintained database to provide information back to counties and citizens. A more detailed description of the Montana method is available at Cadastral Subcommittee's Web site (http://www.nationalcad.org). Details about Tennessee's base mapping program can be found at http://gis.state.tn.us/mapping.html

Distributed databases: The National Map / NC OneMap Project (http://www.nconemap.net) has developed a data access and service engine that provides information at various resolutions depending upon the scale of view. This technology was reviewed at the workshop and the potential for this type of service is just beginning to be explored. *The National Map* / NC OneMap Project utilizes the existing infrastructure and institutional arrangements of local governments demonstrating the ability to seamlessly serve data without having to re-host it in a central repository. It has the ability to provide remote back up for the local sites.

The compilation of parcel data at the state level must be accomplished as a part of normal business operations. Developing a set of best practices for integrating data will provide guidance for those states that do not have methods in place.

[10]Stage, *An Assessment of Parcel Data in the United States*

Conclusions

This workshop and subsequent analysis demonstrated that parcel information acquired to meet local government business requirements are overall the most current and accurate data available for emergency response operations. The concept of vertical integration of data, "create locally and use regionally," is a major objective of the National Spatial Data Infrastructure. An opportunity is at hand to realize this objective with parcel data. The technology is no longer the problem; recent pilot projects have demonstrated the feasibility of creating regional and statewide parcel databases. The issue is how to get started. A strategic initiative such as the National Digital Orthophotography Program (NDOP) is a useful model for implementing a conversion program to encourage digital parcel database development. NDOP was developed in the 1990's because of the strong need for imagery at both the national and local level of governments. Funding was sought by the USGS, approved by Congress, joint funding projects were developed, and today there is a national coverage of one meter orthoimagery that is widely used in every state. Digital parcel data is another data source that has equal if not greater potential because it provides intelligence to the landscape needed in emergency response situations. The difficulty with initiating and funding a parcel data program is that unlike orthoimagery, parcel data has never been used at the national level due to the inaccessibility of this large dataset. Simply put there is little experience at the national level with the benefits and use with this type of data. However, most technology hurdles have now been overcome, and having access to a nationwide parcel layer is no longer unimaginable. Parcel data has recently become a commodity as local governments have built their own parcel databases to address their daily business needs and technology has reached a point that applications can be easily developed to meet many "down stream" user needs.

The findings and recommendations from the Hurricane Isabel Parcel Workshop provide a direction for developing the strategies that need to be implemented to make an integrated national cadastral data infrastructure a reality.

Appendix A
Cross Impact Assessment

The Cross Impact Matrix (p 12) is an assessment of the importance of parcel data to emergency responders during a disaster. The information was based on the Hurricane Isabel Workshop participants (Appendix B) experience with Hurricane Isabel and other emergency response situations. The attendees provided information about specific events and the utility that digital parcel data provides to addressing the information needs in those events. Two methods were used to rank the digital parcel data: (1) *Overall Importance, and (2) Categorical Importance.*

Overall Importance: An indicator of the ***unique*** importance of digital parcel data to resolve the issues described in the event. Three levels of importance were assigned: high, medium, and low:

- High – local government digital parcel data is the only source of information that can address the issues identified in the event.
- Medium – parcel data adds value but there are alternative sources of data that can address the issues.
- Low – digital parcel data can address the issue but it does not add substantial value to other data sources.

Overall Importance accounts for the presence or absence of alternative data sources that can provide the information needed to address the issues. An example is provided by the medium ranking of *Hazardous Materials,* which reflects the knowledge that there are programs that inventory Hazardous Material sites and make that information available to FEMA on a regular basis. This contrasts with the high ranking for *Disaster Area Declaration* where the only source for information about specific property values comes from the local government parcel database.

Categorical Importance: An assessment by ***category*** of how parcel data was used to react to specific events. The principle issues and problems of each event were compiled and a set of nine categories (Table 4) were identified. Each event was then assessed across each of the categories and the cell value indicates the importance that digital parcel data played in addressing the issues of that event. Scores ranged from *critical* to *not applicable* .

The following describes the components of the Cross Impact Matrix. There are five sets of columns: ***Phases, Event Names, Importance, Issues and Needs, and Counts and Totals.*** (Table 1)

1. **Phases** (Table 2) order of occurrence.
2. **Importance** or **Value:** Parcel data was assessed on its overall importance in meeting the needs of the event described. If an alternative data sources that could address the same needs as or more efficiently as a parcel database it was deemed to be of lesser importance (Table 3).
3. **Issues and Needs**: Categories of the types of problems that the workshop attendees identified (Table 4).
4. **Events** (Table 5): These are associated with phases.
5. **Counts and Totals:** *Counts* of the number of relevant issues that were addressed, *Totals* of its overall value, and *Average* score. This allows us to provide a basis of comparison for overall worth.

The importance of parcel data to each category of *Issues and Needs* was assessed by comparing the total number of issues for which parcel data was important, the number of events for which it was critical, and the average value. A brief assessment was given as to what these numbers imply. The values in parenthesis are taken from the last three rows in the table *(Total count across 32 events, total count of critical issues, average value)*

The ability of parcel data to address ***Navigation and Location*** *(20, 4, 2.5)* needs occurred across 20 of 32 issues, more than twice the amount of any other issue. It was of high importance in situations where there was a need to navigate to a specific parcel, this was particularly critical when normal routing was altered or there were significant alternations in the landscape (missing signage). Here navigation by coordinates and GPS was possible because accurate locations could be extracted from the cadastral database. The knowledge that the coordinates are derived from highly accurate data provides confidence in the extracted coordinates. Although parcel data addressed issues in most events, its overall value was not high (2.5) because there are alternative addressing techniques that may not be as accurate but are still functional.

Preparation Time (9, 7, 3.7) was assessed as being the most critical issue for providing access to digital parcel data. *Preparation time* indicates that if parcel data is to be made available it can not be done at the last minute. In addition to the process of converting data from maps to a digital format, *production data* must be processed into a *publication format*, and the users need to be ready to receive the data to make full use of it.

Improving Response Time (9, 6, 3.6) was improved cosiderably if parcel data was at the responders "fingertips." Greatest time savings were accomplished by providing "desk-top visits" that reduced the need for multiple trips to sites and by getting the necessary information to relief organizations faster, which moved all tasks through the queue faster.

Characterization (9, 3, 3.1) was addressed in as many events as *Preparation* and *Improving Response Time* but it was not as critical as the previous items. Characterization is the ability of a parcel database to provide intelligence to the area under evaluation. Combining this with other data sources provides a richness and detail to the data that has great value. Characterizations are crucial in determining economic impact to acquire federal aide and emergency loans.

Spatial Accuracy (6, 3, 3.5) of parcel databases are built to a horizontal accuracy of 6 to 10 ft to meet the business requirements of local governments. This provides the most accurate spatial data source available. These are invariably error checked against large-scale digital orthoimagery (1 ft horizontal accuracy), which provides a another dimension of utility to this data.

***Siting* of Locations** (6, 0, 2.5) was of high importance for debris removal and other events where it was necessary to link a location to an owner.

Economic Impact (5, 4, 3.8): When economic issues were at stake cadastral databases were critical. There were two areas of impact: First at the macro level the determination of overall damage assessment to request emergency relief funds; second at the micro level was to avoid costly errors by having the necessary information to make informed tactical decisions, and using parcel data to expedite funding relief.

Health and Safety (5, 1, 2.8) did not appear to be in critical need of the details of a parcel database except in cases where other data sources were

completely absent. This was the case in *Water Release*, *Power Outages* during ice storms, and *Insect Control* when there was a need to find the spatial locations of specific parcels. Of course these situations further demonstrate that if preparation had not taken place these issues could not have been addressed.

Completeness (4, 1, 3.0) of the databases that are maintained by the local property appraiser to meet their daily business operations are incomparable. These databases provided the most current and complete enumeration of property and structures available.

Computer Modeling (3, 1, 3.3) for emergency situations is mostly within FEMA. They do have data sources for their models but they are estimates of an area derived from the US Census Bureau data. Having more detailed information about each parcel should improve the accuracy of the models. The data requirements of FEMA models needs further analysis. Combining parcel data with other data sets such as elevation data can be viewed as a form of modeling but of a simpler form.

Cross Impact Assessment of the Value of Parcel Data in an Emergency Response Situation

			Categorical Importance													
Phase	Event Name	Overall Importance	Navigation & Location	Improves Response Time	Characterization	Requires Preparation Time	Provides Spatial Accuracy	Siting	Economic Impact	Health and Safety	Completeness	Computer Modeling	Count	Total	Average	Median
All Phases	Location Integration	High			4	3	3						3	10	3.3	
	Communication Protocols	High		3		4							2	7	3.5	
	Identifying People at Risk	Medium	2										1	2	2.0	
	News Media Communication	Low		2									1	2	2.0	
Pre-Event	Hazardous material sites	Medium	4	4						2			3	10	3.3	
	Re-Entry Permits	Medium	2		3	2					3		4	10	2.5	
	Elevation Mapping of Individual Homes	High					4					4	2	8	4.0	
	Temporary Housing for Displaced Pers	Medium	2					2					2	4	2.0	
	Data Backup and Protection	High				4							1	4	4.0	
	Federal Response Staging Areas	Low			1								1	1	1.0	
Response	Water release to protect dams	High	4	4		4	4			4	4		6	24	4.0	
	Disaster Area Declaration	High			4				4			3	3	11	3.7	
	Debris Removal	Medium	3		3			2				3	4	11	2.8	
	Debris Accumulation Modeling	Medium			3		3						2	6	3.0	
	Sewer overflow into river	Low	2										1	2	2.0	
	Pre-Print Maps	Medium	2										1	2	2.0	
	Storm Tracking	Low	1										1	1	1.0	
	Mobile homes and facilities at risk	Medium	2										1	2	2.0	
Recovery	Insect Control - Aerial Spraying	High	4			4			4	3			4	15	3.8	
	Care and Feeding of Farm Animals	High	3			4			4				3	11	3.7	
	Aid Requests for affected areas	High		3	3				4				3	10	3.3	
	Forest resources and downed trees (in	High	3	4						2			3	9	3.0	
	Debris Pick Up and Disposal	High		4				3					2	7	3.5	
	Debris Removal Staging Areas	High		4				3					2	7	3.5	
	Navigation in areas of radical feature c	High	4								3		2	7	3.5	
	Shelter Availability	Medium	2					2					2	4	2.0	
	Hot Spot Mapping	High			4								1	4	4.0	
	Where is grandma	Medium	2										1	2	2.0	
Mitigation	Mitigation Value Estimates	High	2		3		4				2		4	11	2.8	
Planning	Power Outage	Low	2	4		4				3			4	13	3.3	
	Hard Copy Document Protection	High				4			3				2	7	3.5	
	Scheduled Debris Pick Up	High	3					3					2	6	3.0	
	Evacuation Maps	Low	2				3						2	5	2.5	
Total Count across 32 Events			**20**	**9**	**9**	**9**	**6**	**6**	**5**	**5**	**4**	**3**			**7.6**	**6.0**
Total Count of Critical Issues			**4**	**6**	**3**	**7**	**3**	**0**	**4**	**1**	**1**	**1**			**3.0**	**3.0**
Average			**2.6**	**3.6**	**3.1**	**3.7**	**3.5**	**2.5**	**3.8**	**2.8**	**3.0**	**3.3**	**2.3**	**7.1**	**2.9**	**3.2**

Issue Values: 4 = Critical, 3 = Highly Important, 2 = Adds Value, 1 = Low, Blank = Not Applicable

Matrix Columns	
Phases	There are five phases to an emergency response situation: Pre-event, Response, Recovery, Mitigation, and Planning.
Event Names	Participants were asked to describe particular events that occurred during Hurricane Isabel and how parcel data was used or could have been used to address particular events.
Importance	Participants and staff assessed the importance of parcel data to respond to a specific event. Staff ranked the ability and need of digital parcel core data.
Issue and Needs	A categorized set of issues or business requirements that were being addressed.
Totals	Nominal impact score based on the importance and number of issues that parcel data addresses. 1. Count: The number of issue categories that were parcel data could address. 2. Total: Total of issues importance. 3. Average: The average level of importance across the relevant issues 4. Median

Table 1 Description of the matrix columns

Description of Phases	
Phase	**Description**
All Phases	Occurs across all phases
Pre-Event	Anticipation of the event, this phase only occurs with slow moving events like hurricanes.
Response	Reaction to the event during and immediately after the event
Recovery	Post response activities to respond to emergency conditions
Mitigation	Post recovery activities including planning for future events, and mitigation of damage from an event
Planning	Not specific to any event based activities, but centers on routine planning, simulations and preparedness.

Table 2 Five phases of emergency response.

Values used to Rank the Importance of Parcel Data to an Issue Category		
Value	**No.**	**Description**
High+	4	Critical, issue can not be addressed by other methods; high economic impact; avoids disastrous consequences.
High	3	Extremely high improvement in the accuracy of geography or efficiency of operations. Can not be achieved by other means
Medium	2	Adds value to other data sources.
Low	1	Can be accomplished by alternate means
	0	Not Applicable

Table 3 The ability of digital parcel data to address a particular need.

Issue Categories and the Number Ranked by the Number of Critical Issues		
Category	**Description**	**Critical Issues**
Requires Preparation Time	The importance of lead time to enable a resource.	7
Improves Response Time	Improvements in response time have two impacts: 1) frees up resources to address other issues; 2) facilitates ability to respond to a request.	6
Economic Impact	Averts loss to business and assets; facilitates access to aide.	4
Navigation & Location	Ties information to geography.	4
Provides Spatial Accuracy	Improvements in the resolution of geography or completeness of information.	3
Characterization	Provides information about the structures (improvements) on a property.	3
Completeness	Updated on a regular and basis.	1
Health and Safety	Human Health and Safety	1
Computer Modeling	Valuable to computer modeling.	1
Siting	Location of suitable parcels to address a particular need.	0

Table 4 Description of categories for issues and needs arranged by the number of events for which they were critical.

Description of Events	
Event Name	**Event Description**
Aid Requests for Affected Areas	Data is needed to support landowners and business applications for post event storm relief.
Care and Feeding of Farm Animals	Transporting feed to farms after and event.
Communication Protocols	Local data needs to be included in FEMA protocols in order to make the data readily available during an event.
Data Backup and Protection	All current production and publication data needs to be copied and backed up in a transportable format to protect against possible outage at storm center.
Debris Accumulation Modeling	On-site debris location during and event which includes plotting, classifying and tracking debris.
Debris Pick Up and Disposal	Identify the debris dumping areas so that debris can be collected and disposed of. The different types of debris will require different locations.
Debris Removal	Need to know the locations of blocked roads and what is needed to clear them.
Debris Removal Staging Areas	Identification of parcels that can be use for debris removal.
Disaster Area Declaration	Federal and State declarations of a national disaster.
Elevation Mapping of Individual Homes	Just prior to the event there were a lot of requests from individual homeowners asking what the elevation of their home was so they could prepare for the storm properly.
Evacuation Maps	Design and evacuation maps that can be provided in advance of the storm and widely publicized.
Federal Response Staging Areas	Locating and assembling generators, tarps, people, water, portable toilets, and other equipment.
Forest Resources and Downed Trees (in streams)	Recovery of forest resources after a storm.
Hard Copy Document Protection	This is the protection of the hard copy records like deeds and maps and other records.
Hazardous Material Sites	Location of hazardous material sites so that these areas can be monitored during the event for potential response.
Hot Spot Mapping	These are areas of repeated damage over multiple events.
Identifying People at Risk	A pre-event estimation of where people at risk are located and what their evacuation and service needs may be.
Insect Control - Aerial Spraying	Spraying for mosquitoes and other insects to prevent disease and other problems.
Location Integration	The integration of the various point positions with the same coordinate system and datum, as well as the vertical integration of various data sets.
Mitigation Value Estimates	This is an ongoing process to have the potential values of

Description of Events	
Event Name	**Event Description**
	affected areas estimated prior to an event.
Mobile homes and facilities at risk	Identify areas that will most likely be at risk in the path of the storm.
Navigation in Areas of Radical Feature Changes	Responders or claims adjusters that go into areas where land marks have been radically altered or destroyed can spend a lot of time simply determining if they are at the correct locations.
News Media Communication	The management of the information for the news media, timing, and providing them enough information to be useful.
Notification of Available Data	The counties are not getting prompt notification that federal and state agencies have information that they can use.
Power Outage	Tracking power outage during hurricane Isabel was highly important to return the community to normal but it is critical in ice storms when the cold can be a life threatening to the disabled.
Pre-Print Maps	Because the hurricane is slow in coming, there is time to pre-print maps for the response and recovery crews.
Re-Entry Permits	The re-entry permits are generated by the county every two years prior to the hurricane season based on mailings to landowners.
Road closures and bridge outages	Identify where roads are still open, where roads are blocked and the reasons for the blockage.
Scheduled Debris Pick Up	Schedule for collecting different types of debris from residents and businesses.
Sewer Overflow into River	Identify areas or instances where sewers or septic tanks have overflowed into rivers and created contamination zones.
Shelter Availability	Identification of where the shelters are located, their capacity, services and how to get to them.
Storm Tracking	Tracking the path of the storm and the predicted landfall in its path.
Temporary Housing for Displaced Persons	People are displaced by the storm for temporary housing.
Water Release to Protect dams	Falls dam on the Neuse river had a water release after a hurricane to save the dam and create capacity for additional run-off.
Where is Grandma?	Non-emergency calls from people outside the area looking for family that are known to be in the storm but are not responding to telephone calls.

Table 5 Description of events

Appendix B
Workshop Attendees

Names	Organization
Anderson, Dennis	North Carolina Department of Transportation
Averett, Steve	Gaston County
Ball, Greg	Dare County
Brown, Jeffrey	North Carolina Center for Geographic Information & Analysis
Friddle, Charles	Wake County
Giordano, David	North Carolina Center for Geographic Information & Analysis
Gray, Tommy	Dare County
Heavner, Jay	Gaston County
Herlong, David	North Carolina Center for Emergency Management
Holloway, Don	Gaston County, GIS Consultant
Humphrey, Wayland	Lenoir County
Kannan, Chris	United States Geological Survey
Kimmel, Stacey E.	North Carolina Center for Geographic Information & Analysis
Lawson, David	Federal Emergency Management Adminstration (FEMA)
Lowe, Jane	Buncombe County
Madding, Dan	North Carolina Department of Agriculture
Minneman, Rex	North Carolina Land Records Management Program
Nagy, Zsolt	North Carolina Center for Geographic Information & Analysis
Oporto, Frank	Federal Emergency Management Adminstration (FEMA)
Payne, Anne	Wake County
Pike, Patricia	Onslow County
Smith, Mark	North Carolina Emergency Management, Mitigation
Stage, David	Cadastral Subcommitte, Eastern Cadastral Coordinator
Stamper, Julie	Pasquotank County
Thompson, Gary	North Carolina Geodetic Survey
von Meyer, Nancy	Cadastral Subcommittee, Secretary
Wray, David	North Carolina Department of Agriculture
Wray, Sarah	North Carolina Floodplain Mapping Program