DETERMINING DISASTER DATA MANAGEMENT NEEDS IN A MULTI-DISASTER CONTEXT

by

Elizabeth A. Harris
William J. Rasdorf
Debra F. Laefer

Final Report
NSF Project Supplement CMS-0451461
To NSF Grant CMS-0353175

Department of Civil Engineering
North Carolina State University
Raleigh, NC

December 16, 2005

ACKNOWLEDGEMENTS

This work was supported by NSF project CMS-0353175 and by an NSF Graduate Research Fellowship. Any opinions, findings and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect those of the National Science Foundation.

Special thanks to the members of the Workshop Planning Committee, Dr. Kenneth B. Taylor, Dr. Edd Hauser, and Dr. Stephen Meinhold, for their generous assistance with this study.

EXECUTIVE SUMMARY

In the last four decades, the economic loss from natural hazard disasters has increased ten-fold. The increasing human and economic impacts of disasters have intensified efforts on the global, national, state, and local levels to find ways to reduce these impacts. Improved collection and management of disaster data can help support planning and decision-making by first responders and emergency managers during all phases of the disaster cycle. The goal of this report is to establish what disaster-related data are needed in the planning, response, and recovery for multiple types of disasters, with a focus on the data needs in the state of North Carolina.

There is a vast amount of information available from all phases of a disaster. Unfortunately, without proper collection, documentation, and storage, the information is either completely lost or is not transformed into functional data. Often, data that are critical for developing better mitigation efforts is not collected because much of it is short-lived and is lost prior to collection.

Increased use of instrumentation, such as water level gauges and data collection and analysis software, can aid in collecting and disseminating real-time critical disaster data. The deployment of rapid-response data collection teams immediately after a disaster event can also improve the quantity and quality of data obtained during a disaster. Disaster management systems help first responders and emergency managers formulate and discriminate their decisions before, during, and after a disaster and therefore can serve as a way to organize, analyze, and disseminate critical disaster data.

Groups of researchers and emergency management professionals in NC are trying to improve the collection and dissemination of disaster data in order to improve disaster preparation and response. Researchers at North Carolina State University (NCSU) were looking at all phases of data collection in a multi-disaster context. Another group, the North Carolina Institute of Disaster Studies, hosted two previous workshops to better coordinate collaboration between emergency responders and academics throughout the state. These efforts, as well as the disaster data collection research efforts of the North Carolina Emergency Management Division, resulted in a need to gather members of the academic and emergency management community together to obtain a more accurate picture of multi-disaster data collection and use, and to develop the foundation for a consensus on areas of disaster data management that needed improvement. A Disaster Data Workshop, held at NCSU November 4-5, 2004, was chosen as one way to address the data collection and dissemination issues in a context of broad, statewide participation.

The workshop planning committee determined that the approximately 30-40 workshop participants would discuss four different disasters in-depth. The four disasters chosen by the workshop planning committee to discuss in the workshop were hurricane and tornado wind, flood, ice storm, and intentional explosion. The first three disasters chosen are the most frequent natural disasters in NC, while the intentional explosion disaster was chosen so that an intentional man-made disaster would be included in the workshop.

The five objectives of the NCSU Disaster Data Workshop on “Determining Disaster Data Needs in a Multi-Disaster Context” were as follows.

- Evaluate the applicability of a general multi-disaster model,

- Understand local data needs and opportunities,
- Establish clear models of organizational participation in collection and use,
- Define a common data set for multiple disasters, and
- Lay the groundwork for establishment of data collection teams.

The workshop's structure was based on meeting the five workshop objectives within the available time. The five sessions of the workshop were data needs, data resources, data dissemination, common data set, and data collection teams.

From the participants' discussions on disaster data during the workshop sessions, some common themes emerged. The emerging themes on data needs, resources, and data dissemination were used to create and implement a multi-disaster data model. The model was developed by the workshop planning committee. The discussions on data needs and resources also led to the identification of data items that participants in each of the four disaster groups indicated were needed for their assigned disaster. These needed data items form a common data set for the four disasters investigated by the workshop, as well as possibly for other disasters not investigated. Also generated from the workshop discussions were a set of disaster data collection and management priorities for NC.

From this research study, from the NCSU Disaster Data Workshop results, and from previous workshops and disaster management systems efforts, several conclusions can be drawn about disaster data and its management. Existing data collection and management efforts focus primarily on inventory data, since this information is available regardless of a disaster event. The development of data collection teams and a data repository in NC is needed and would contribute to disaster research and emergency management efforts. The four areas model developed from the workshop allows all of the data items the workshop participants could think of to be assigned to a data area. The common data set model developed from the workshop is also biased toward the data needs for NC, and may need to be modified for application in other regions. Also, a disaster data collection and management cycle was developed from the workshop discussions. This cycle can serve as an agenda for the development and operations of both disaster data collection teams and a common disaster data repository.

Recommendations from this study for NC include more research in the area of ice storms, an additional workshop to discuss the further development of data collection teams and coordinated data management in the state, and developing a common disaster data repository in NC. Broader recommendations in the area of disaster data management include prioritizing data set development based on how critical the data set is to a region's disaster preparedness and response, ensuring that disaster data collection teams are self-reliant, investigating more disaster types to better understand their data needs and resources, and improving data collection efforts through increased use of instrumentation and cooperation between emergency management organizations and managers of infrastructure systems such as transportation and utilities.

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INTRODUCTION

According to United Nations estimates, each year 100,000 lives are lost due to disasters caused by nature, and the global cost of disasters will top $300 billion annually by 2050 (UNISDR, 2002). In the last four decades, the economic loss from natural hazard disasters has increased ten-fold (McDonald, 2003). Population shifts from rural to urban and suburban areas have both increased the density of inhabited areas and encouraged people to move into areas that are more vulnerable to natural disasters. The increasing human and economic impacts of disasters have intensified efforts on global, national, state, and local levels to find ways to reduce these impacts.

Disasters

There are several existing definitions for a disaster. Disaster researcher Charles E. Fritz has defined a disaster as:

> "An event concentrated in time and space, in which a society, or a relatively self-sufficient subdivision of a society, undergoes severe danger and incurs such losses to its members and physical appurtenances that the social structure is disrupted and the fulfillment of all or some of the essential functions of the society is prevented." (Tierney, 2001)

An alternate, but similar definition is that "a disaster can be defined as an event, either natural or man-made, which has the ability to destroy life, natural landscape, and man-made infrastructure. The same event, in different circumstances, could be a source of scientific data or a deadly catastrophe. It all depends on where it took place and how it was perceived" (McDonald, 2003). A simpler, systems-focused definition of a disaster is that it involves demands that exceed capabilities (Tierney, 2001).

These three definitions emphasize that a disaster must meet two criteria. First, a natural hazards or man-made event needs to be powerful enough to cause human, natural, or infrastructure damage, and second, this event must actually cause human and infrastructure damage that severely impacts the function of society. For example, a powerful earthquake (6.5 magnitude) in a remote area of China might not be considered a major disaster if only minor human and infrastructure damage occurs, but if that same earthquake occurred in an urban center, the devastation and resulting loss of lives would qualify the event as a major disaster.

Disasters are typically divided into three main categories: natural hazard, man-made, and humanitarian disasters (IFRC, 2005). Most damage from natural hazard disasters is physical, such as fallen trees and flooded homes due to natural phenomena, like floods and earthquakes. Man-made disasters are a result of human, and not natural activities. Examples of man-made disasters include nuclear accidents and dam failures. Humanitarian disasters, although they can have natural or man-made causes, are those disasters that impact humans more than the physical environment. Examples of these are people movement and famine.

Disaster Types

There is no single agreed upon standard list of disaster types within the disaster research community. Depending on both the mission of the organization or researcher(s), the selected definition emphasizes certain disaster categories, while excluding others. For example, the Federal Emergency Management Agency's (FEMA) list of disaster types consists mostly of natural hazards and man-made disasters, including those man-made disasters caused by terrorism and hazardous materials. The International Federation of Red Cross and Red Crescent Societies' (IFRC) disaster types focus more on humanitarian disasters than does FEMA's list, probably because the IFRC's main mission is medical and humanitarian care.

Table 1 presents the IFRC's and FEMA's lists of disaster types (IFRC, 2005, FEMA, 2005a). Disaster types that are included in both organizations' lists have been shaded and displayed in the same row, and disaster types that are in the same category have been grouped together. There is commonality of the two lists for only four natural disaster types: hurricanes, earthquakes, floods, and volcanoes. FEMA's list includes many more natural hazards, such as wildfires and tsunamis, than IFRC's list. However, FEMA does not list any humanitarian disasters, such as famine and population movement, as disaster types. FEMA and IFRC both include man-made disasters on their lists of disaster types, but FEMA's list goes into more detail and includes nuclear and terrorism disaster types among others.

Table 1. IFRC and FEMA Disaster Types

Disaster Category	IFRC Disaster Types	FEMA Disaster Types
Natural Hazards	Hurricanes, cyclones and typhoons	Hurricanes
	Earthquakes	Earthquakes
	Floods	Floods
	Volcanic eruption	Volcanoes
		Fires
		Wildfires
		Landslides
		Thunderstorms
		Winter Storms
		Tornadoes
		Tsunamis
		Extreme Heat
	Drought	
Humanitarian	Famine/food insecurity	
	Epidemics	
	Population movement	
Man-made		Multi-Hazard
	Man-made disasters	
		Terrorism
	Technological	
		Dam Safety
		Hazardous Materials
		Nuclear

The study of disasters in this civil engineering research report focuses on disasters that especially impact infrastructure; thus humanitarian disaster types will not be considered candidate disaster types for this study. The list of disaster types considered herein, and their cause(s) are given in Table 2. This comprehensive list was compiled from accumulation of the ICRC and FEMA disaster type lists as well as from additional research and research group discussion. The list introduces a new term, disaster factor, which is defined as the agent causing human, natural, or infrastructure damage. For example, both earthquakes and volcanoes are caused by tectonic changes in the earth's crust.

The Disaster types listed in Table 2 are grouped by the disaster factor, and are biased towards disasters that affect infrastructure. Classifying the disaster types by disaster factor allows disaster types that have similar damaging effects on infrastructure to be grouped together. It also presupposes that if the disaster types have a similar damaging effect on infrastructure they will also require similar preparation, response, and recovery efforts from the disaster community.

As shown in Table 2, each disaster type can have multiple causes, with the most common causes being nature, neglect, and intentional. Disasters caused by nature, such as a flood, can be mitigated against to reduce damage, but some damage will still occur because the disaster event cannot be entirely prevented. Eliminating accidental human error through improved resource management can theoretically prevent disasters caused by neglect, but in reality accidents will still occur, causing the mitigation efforts already in place for nature-caused disasters to also assist in mitigating the neglect-caused disasters.

Intentional disasters are the most difficult to prepare for because they depend on a human deliberately harming infrastructure or people by causing a disaster event. Not all intentional disaster events are terrorism, but all terrorism is intentional. For example, one can intentionally commit arson by setting fire to a structure, but unless this person is attempting to make a political or terrorist statement, it is simply a criminal act. The line between criminal and terrorist acts is still being defined and discussed in the American legal system and in government. All disaster type/disaster cause combinations that could reasonably be precipitated as a terrorist act are indicated by "yes" in the ***Terror*** column in Table 2.

The Disaster Cycle

The disaster cycle includes the steps taken by a society before, during, and after a disaster event to manage a disaster. The disaster cycle can be characterized as consisting of of six phases, identification, prediction, mitigation, preparation, response, and recovery (Pradhan, 2003). The order of the phases and their relationship to the disaster event is shown in Figure 1 (Pradhan, 2003). Each phase of the disaster cycle will differ in content based on the type of disaster being managed. Therefore, each disaster type will have its own disaster cycle that reflects what is necessary to manage that particular disaster type.

The disaster cycle begins with the identification phase, where the physical and human infrastructure that is in the most danger from a particular disaster is identified. Threatened physical infrastructure could include roads, buildings, bridges, etc., which are vulnerable to the disaster type, while the threatened human infrastructure might include fire stations and hospital beds.

Table 2. Disaster Types and Causes

Disaster Factor	Disaster Type	Cause	Terror
Wind	Hurricane	Nature	
	Severe Wind Storm/Tornado	Nature	
Water	Flood	Nature	
		Neglect	
		Dam Failure	yes
	Winter/Ice Storm	Nature	
	Drought	Nature	
		Desertification	
	Hail Storm	Nature	
Tectonic	Earthquake	Nature	
	Volcano	Nature	
	Tsunami	Nature	
Conflagration	Wildfire	Lightning	
		Neglect	
		Arson	yes
	Building/Urban/Suburban Fire	Lightning	
		Neglect	
		Electrical	
		Arson	yes
	Pipeline Fire	*Neglect*	
		Arson	yes
	Oil well Fire	*Neglect*	
		Arson	yes
	Explosion	*Neglect*	
		Detonated Bomb	yes
		Transportation "Accident"	yes
	Mine explosion	*Neglect*	
		Intentional	yes
Pathogen/Toxic material	Epidemic	Nature	
		Neglect	
		Bioterrorism	yes
	HazMat spill	*Neglect*	
		Transportation "Accident"	yes
		Intentional	yes
Radiation	Nuclear Plant "Accident"	*Neglect*	
		Intentional	yes
	Nuclear Bomb	*Neglect*	
		Intentional	yes
	Dirty Bomb	*Neglect*	
		Intentional	yes
Temperature	Heat	Nature	
	Extreme Cold	Nature	
Material Impact	Hail Storm	Nature	
	Slope Failure / Landslide	Nature	
		Neglect	
		Intentional	yes
	Transportation "accident"	Nature	
		Neglect	
		Intentional	yes
	Mine collapse	Nature	
		Neglect	
		Intentional	yes

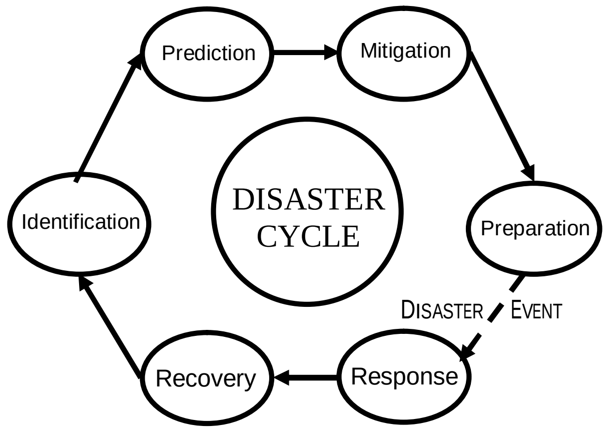

Figure 1. Six Phases of the Disaster Management Cycle

After the threatened physical and human infrastructure is recognized in the identification phase, the level of damage to the threatened physical and human infrastructure is determined in the prediction phase. The prediction phase consists of conceiving of a danger and assessing its potential impacts on the community. Physical impacts to the community could include property loss and utility service interruption. Human community impacts may include predicting the possible loss of life due to a disaster and calculating the number of citizens that need to be evacuated from the area.

The mitigation phase seeks to reduce the predicted effects of a disaster event by developing and implementing plans to minimize damage to physical and human infrastructure. Physical infrastructure mitigation efforts could include installing plywood to cover windows and raising the elevation of houses in the floodplain. Backup generators for hospitals and protective garments for emergency workers are examples of human infrastructure mitigation efforts.

Prior to a disaster event and after the identification, prediction, and mitigation phases have been completed, the preparation phase will occur. The preparation phase includes the activities needed to prepare for disaster emergencies that cannot be fully mitigated against. For example, scattering salt and sand on roads and stacking sandbags around buildings are ways to prepare the physical infrastructure for a disaster. Preparations to prevent human casualties can include notifications, evacuations, and containment strategies.

Once the disaster event has begun, the response phase commences. The response phase consists of a set of actions constituting a reply or a reaction during and immediately following a disaster. The government and citizens make attempts to protect and rescue impacted human and physical infrastructure as the disaster unfolds.

The recovery phase begins shortly after the end of a disaster event. This phase includes the restoration of disaster-stricken areas and communities after the disaster event. Houses and businesses are repaired, lost utilities are restored, and the physical and psychological healing of humans also occurs.

Major Disaster Mitigation and Response Organizations

In the United States, the government agency responsible for national disaster management is the Federal Emergency Management Agency (FEMA). FEMA, created in 1979, was an independent US government agency until 2003 when it was assigned to the Department of Homeland Security. FEMA is involved in coordinating state and local efforts for all six disaster cycle phases. After an event is declared by the President to be a federal disaster, affected state and local governments as well as affected citizens and businesses can request financial assistance under the Robert T. Stafford Disaster Assistance and Recovery Act. FEMA is also involved in funding first responder training and emergency planning efforts.

On the international level, the International Federation of Red Cross and Red Crescent Societies (IFRC) and the United Nations (UN) are involved in global disaster management. The IFRC, founded in 1919, focuses primarily on providing humanitarian relief through its member societies during and after disaster events. The IFRC has two sets of specially trained teams, the Emergency Response Units and the Field Assessment and Coordination Teams that provide specialized volunteers, needed equipment, and trained disaster managers to affected areas. The IFRC also maintains a Disaster Management Information System on the Internet that has disaster management tools and databases and a Disaster Relief Emergency Fund for assistance (IFRC, 2005).

Within the UN, two groups, the United Nations Office for the Coordination of Humanitarian Affairs (OCHA) and the International Strategy for Disaster Reduction (ISDR) play a role in disaster mitigation and response. The ISDR is focused on the first four phases of the disaster cycle (Identification, Prediction, Mitigation, and Preparation). The ISDR has a goal of "reducing human, social, economic and environmental losses due to natural hazards and related technological and environmental disasters" (UNISDR, 2005). The ISDR runs an international disaster risk reduction training program that seeks to achieve the following four objectives:

- Increase public awareness to understand risk, vulnerability, and disaster reduction globally,
- Obtain commitment from public authorities to implement disaster reduction policies and actions,
- Stimulate interdisciplinary and intersectoral partnerships, including the expansion of risk reduction networks, and
- Improve scientific knowledge about disaster reduction.

Within the United Nations Office for the Coordination of Humanitarian Affairs (OCHA), there are two groups that are involved directly in disaster response. The United Nations Disaster Assessment and Coordination Team (UNDAC) can be deployed within 24 hours to a disaster location to collect disaster information and coordinate disaster response between the local government and regional and international assistance resources. The International Urban Search and Rescue Teams (IUSRT) of OCHA can be summoned within 12 hours of a disaster that causes building collapses, such as an earthquake. IUSRT provides expertise and assistance to local search and rescue efforts (OCHA, 2004).

Study Goal and Objectives

During all phases of the disaster cycle, current and accurate disaster data is necessary to support planning and decision-making by first responders and emergency managers. The goal of this study is to determine what disaster-related data is generally needed in for all disaster phases for multiple types of disasters, with a focus on the data needs in the state of NC. In order to determine these disaster data needs, this project seeks to meet the following objectives.

1. Identify existing disaster data collection and management systems and determine what data they collect and use,
2. Study the results of previous disaster-related organizational efforts to deal with disaster data,
3. Generate a common disaster data set based on research from this study as well as work by others, and
4. Recommend how to apply the common disaster data set in future work and studies, for example, serving as the initial baseline data set for disaster management systems and as a data repository for disaster data collection teams.

The first objective provides a sense of what the current status of disaster data collection and management system efforts is, as well as an identification of what data items are collected or included in these efforts. The disaster data work done by the Earthquake Engineering Research Institute (EERI), the North Carolina Institute of Disaster Studies (NCIDS), the North Carolina Emergency Management Division (NCEM), and North Carolina State University (NCSU) is examined to meet the second objective. The experiences of NCIDS and NCEM are especially helpful in determining disaster data needs in NC.

The third objective is the main research focus of this study. It involves the synthesis of the common data items identified at a disaster data workshop held in Raleigh, NC and the disaster data items categorized in other research efforts. Issues of disaster data format, data dissemination, team data collection, and data management for the common data set are discussed. Recommendations regarding these issues are made to satisfy the fourth objective. The rest of this report addresses and discusses each of the preceding objectives, beginning with the first objective, to describe existing disaster data collection and management systems and what data they collect and use.

Disaster Data: Collection, Coordination, and Use

A disaster creates an information need by governmental, business, and academic communities for both efficient disaster response and improved preparedness for future disasters. How this information is collected, stored, managed, and disseminated influences the effectiveness of disaster management during each of the six phases of the disaster cycle.

Data Collection and Transformation

There is a vast amount of information available from all phases of a disaster. Unfortunately, without proper collection, documentation, and storage, the information is either lost or is not transformed into functional data. For example, immediately following Hurricane Isabel in 2003, seven different federal and state agencies documented the coastal damage along the Outer Banks in NC. This information was collected in multiple formats (video, orthophotography, satellite imagery) and typically lacked reference locations and dates, thereby making it unusable for further analysis. Because the coastal damage information was poorly documented and labeled, it could not be converted from raw information to functional data. Manipulating and analyzing functional data then creates practical knowledge, as shown in Figure 2, which can be applied to mitigation and prevention of future disasters.

Raw Information → Functional Data → Knowledge

Figure 2. Transformation of Data into Knowledge

Often, the critical data necessary for developing better disaster mitigation efforts is not collected because much of the disaster information is short-lived. If it is not actually collected it may be lost. For example, information on structural damage due to a hurricane is lost within a week of the event, because owners begin to repair or demolish the structure. Similarly, high water marks are often lost with the first subsequent rainfall. Methods for collecting this data before it is lost must be developed.

Critical data is also not collected because the existing data collection infrastructure is not fully utilized. For example, all bridges in NC are already outfitted with sensors to measure temperature, but they are not equipped with sensors to measure wind speed or water level, which are critical data to document hurricanes. Fully utilizing current data collection opportunities can prevent data from disappearing during a disaster event. Adding data collection capacity maximizes the amount of useful information gathered while minimizing the associated cost. Other similar cost sensitive data collection ideas need to be pursued.

<u>Instrumentation</u>

Instrumentation facilitates data collection before, during, and after a disaster. The capabilities for real-time processing of sensor-collected data using computers and wireless networks not only exist but also are currently being implemented. Data collecting sensors can either be installed prior to a disaster event to monitor conditions during an event in real-time or they can be deployed in response to an event to assist in response and recovery efforts. For example, cameras attached to robotic snakes are sensors that can be used to enter collapsed buildings after a disaster and search for victims. Sensor networks need software applications that can quickly retrieve and analyze sensor data for interpretation by emergency management professionals.

Prior to a disaster event, instrumentation should be installed and tested for functionality. Installed sensors can be used to obtain the base level conditions in the system being measured. Before an event is also a good time to test the interoperability of sensors, high-speed data servers, and data collecting software. The data collecting software can be interfaced with a spatial database to enable better visualization in a GIS of the system being measured during a future disaster event. Spatial data for a sensor can come from a Global Positioning System (GPS) unit reading when it is installed or inspected. Planning and scheduling software that is used to coordinate the disaster response should also be tested prior to a disaster event.

Many types of sensors and sensor networks are used to collect disaster data during an event. In the earthquake and meteorological research fields, the use of sensors such as accelerographs and Doppler radar, respectively, is highly developed. The California strong motion instrumentation program (CSMIP) is a statewide network of accelerographs installed in geologic materials and in over 900 structures, such as buildings, hospitals, bridges, dams, utilities and industrial facilities (CSMIP, 2005). Data from the accelerographs, including acceleration, velocity, displacement, and duration of motion, is either collected from each instrument manually or is relayed to the CSMIP headquarters via modem whenever ground or structural motion is detected. Ground motion data is used to rapidly create maps showing the levels of ground motion in the affected area; structural motion data is used to analyze the performance of structures under earthquake loads and to alert headquarters of any sensed large motion.

In the Houston area, next generation radar (NEXRAD) real-time rainfall estimates are used in hydrologic models to predict flooding levels (Bedient, 2003). Other areas, such as flood control, are beginning to develop. In Palo Alto, California, a real-time, web-based, flood warning system has been developed using water level sensors (on bridges), rain gauges, flood basin detectors, tide monitors, and a closed circuit television camera (FHWA, 2003).

Instrumentation of structures typically either involves monitoring for structural motion (e.g. the CSMIP) or to monitor structural health by installing sensors that measure the stress, strain, or both on a structural member. Structural health efforts generally focus on critical structures such as bridges, dams, important large buildings, and buildings with a history of failure problems because monitoring all buildings would be costly and require intensive data processing. In the Sacramento River delta in California, a levee that is in danger of failing has been successfully outfitted with real-time sensors that identify distortion and notify crews that emergency repairs are necessary (Broad, 2005). Recently, the use of fiber-optic sensors to monitor cracks, temperature change, strain, incline, acceleration, and corrosion has become more common because these sensors are inexpensive, rugged, lightweight, and can have many sensors installed on a single fiber (Casas, 2004). Advances in wireless communications are also making it easier to monitor structural health (Lynch, 2003). After a disaster occurs, remote sensing techniques, such as LIDAR, can be used to judge the extent of structural damage and generate three-dimensional building models.

A real-time sensor system designed to effectively collect important data during a disaster should be designed with the most likely disaster threats in mind. A basic sensor system could include temperature, lake and stream water levels, wind speed, wind direction, and other meteorological factors that promote real-time information on wind and water levels, two common causes of disaster damage.

During the response and recovery phases of a disaster event, sensors, GPS, and software can be utilized to collect data about response resources and extent of damage. Mobile GPS sensor units installed in disaster response vehicles as well as radio frequency identification tags on response supplies and equipment can be used to track the locations of disaster response resources. Data collection teams in the field can be equipped with GPS-enabled personal data assistants (PDAs) that have data collection forms and analysis software pre-installed. For example, these PDAs can collect data about the level of building damage and the location (through GPS) of the damaged structure. Spatial database software can take the data collected from the PDAs and display it in a GIS to inform decision makers and researchers. Sensors, sensor networks, spatial sensors (GPS), and data management software assist in collecting and processing attribute and spatial information about hazards threatening an area, levels of damage, and the quantities and locations of response resources.

Coordination of Data Collection Efforts

The lack of coordination and standards for information collected during disasters prevents important disaster research efforts from advancing. The problems in collecting short-lived disaster data stem from a lack of awareness of what data to collect and a lack of pre-disaster coordination between agencies. Presently in NC, there is no pre-disaster organization to form disaster response teams on the local and state level to coordinate data collection for a particular disaster.

Ideally, data collection teams would be comprised of government agency representatives, expert university faculty, and their research assistants, all of whom have been pre-coordinated into teams to respond quickly to collect disaster data. Furthermore, there needs to be a predetermined agreement within the disaster research community on what data should be collected for a particular disaster and how that should be done (format, extent, geo-spatial reference, etc.). The teams would have to be organized to ensure that the correct data is collected and that there are enough team members to do so. Presently, when a disaster occurs, only a few national disaster response teams with highly limited scopes of interest, such as for earthquake response, have been pre-coordinated for deployment.

Disaster Management Systems

Disaster management systems (DMSs) typically consist of one to three main parts; a database of disaster data, a set of procedures for disaster response, and models for predicting the extent of disaster damage (using the database). DMSs addressing one or two of the main parts typically focus on one or several of the disaster cycle phases, while DMSs that include all three parts may focus on all phases of the disaster cycle. Most DMSs focus on multiple disaster types so they can be applicable in multiple disaster situations. Four disaster management systems are discussed in this section.

- HAZUS-MH,
- Incident Management Systems,
- Kovel Disaster Database Model, and
- Southwestern Indiana Disaster Management System.

Each of these disaster management system discussions is organized in a similar manner, emphasizing each of the following three topics. That is, for each disaster management system, at least these three topics are discussed.

– DMS characteristics,
– Data items utilized in the DMS, and
– Relevance of the DMS to this project.

HAZUS-MH

FEMA's hazard modeling tool, HAZUS-MH, short for HAZards U.S. Multi-Hazard, contains models for estimating potential losses from floods, earthquakes, and hurricane winds (FEMA, 2005b). The original HAZUS released in 1997 only considered earthquakes. HAZUS-MH is a Geographic Information System (GIS)-based system that classifies buildings and lifeline systems (utilities) according to a nationally standardized methodology. There are three levels of analysis refinement, or detail to HAZUS-MH, depending on the level of detail of the database from which HAZUS-MH draws (either national or local level detail data) and the sophistication of the modeling (Hooke, 2000). The three analysis levels of HAZUS-MH are illustrated in Figure 3 (FEMA, 2005b).

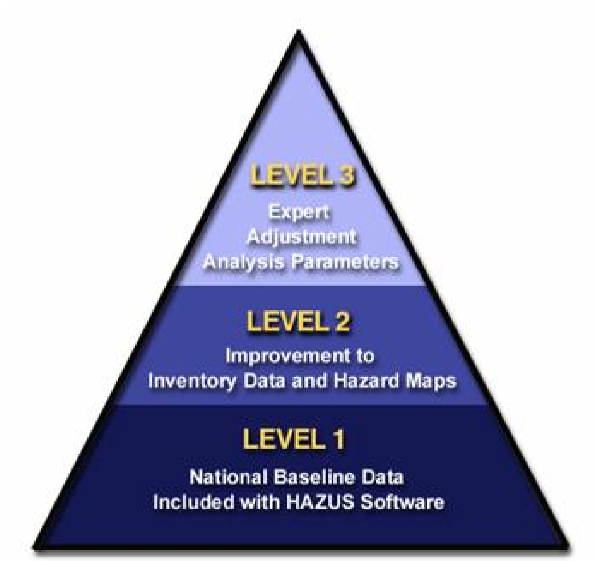

Figure 3. HAZUS-MH Analysis Levels

One large component of HAZUS-MH is the data for the loss estimation model. Three types of data are utilized in HAZUS-MH: hazard, inventory, and vulnerability data. A Level 1 analysis uses only the national baseline data, which is included with the HAZUS-MH model from FEMA and contains mostly hazard and inventory data. The hazard data consists of information about historic flood, hurricane, and earthquake events, as well as area characteristics that influence how each hazard impacts a given area (FEMA, 2004). The inventory data provided in HAZUS-MH consists of information about demographics, the economic base, and structures developed from national and regional data sets such as databases from the U.S. Census. Appendix A lists the inventory data sets that are shipped with HAZUS-MH.

For Level 2 and 3 analyses, the hazard and inventory data is augmented with local information and vulnerability data, which requires refinement for the local area. To enter local data into HAZUS-MH in order to complete a Level 2 analysis, FEMA provides three tools.

1. The Inventory Collection Tool (InCAST) is a software application to facilitate the collection of building-specific data for HAZUS-MH.
2. The Building Inventory Tool (BIT) is used to import building data (e.g. from a tax assessor).
3. The Flood Information Tool (FIT) helps users manipulate local flood data into the required HAZUS-MH flood model format (FEMA, 2005b).

A Level 3 analysis requires not only local data, but also an adjustment of the HAZUS-MH program parameters for a specific hazard situation, location, or both.

HAZUS-MH, and its preceding program, HAZUS, has been used nationally to tackle earthquake, wind, and flood disasters. In the Portland, Oregon metropolitan area a Level 2 HAZUS analysis was completed in 1999 to model the potential damage to local buildings and lifelines due to an earthquake. The analysts chose to do a Level 2 analysis because the baseline data included with HAZUS had been aggregated at a lower level of detail than the analysis required (Hasenberg, 1999). A building survey of 50,000 non-single family residential buildings was added to HAZUS, as well as information about essential facilities and lifelines (medical care facilities, emergency response facilities, and schools). In Austin, Texas in 2000, the Flood Information Tool (FIT) and a database of property values by parcel and finished floor elevations was used in a HAZUS-MH analysis to estimate flood depths. Knowing the flood depths, HAZUS-MH then was able to estimate loss in terms of the amount of flood damage that would occur in each building and the cost of that damage for a flood of a particular magnitude. This information in turn was used to set priorities for and justify flood mitigation efforts in Austin (Srinivasan, 2003).

In terms of this disaster data study, HAZUS-MH provides guidance with respect to possible common data sets and potential data formats. The list of data items included in the baseline data of the HAZUS-MH program, shown in Appendix A, provides a preliminary data set for the common disaster data set this study is attempting to develop. However, the data sets in HAZUS-MH focus primarily on infrastructure information, and less on population and hazard data. The data requirements for Level 2 and Level 3 analyses can aid in identifying additional data that is needed by these levels and the creation of data sets from this collected data. Since HAZUS-MH uses a GIS format or tabular format (which is GIS compatible) for all or most of its data, these formats should be considered in this project when suggesting the formats to use in the common data set.

Incident Management Systems

Incident Management Systems (IMSs) play an important role in the response phase of a disaster event. An IMS is a tool for coordinating and marshalling pre-identified and pre-assembled resources to respond to an emergency or disaster (Perry, 2003). Resources include response personnel (first responders), materials, and equipment. There are national, state, local, and disaster-specific IMSs in existence. Examples of IMSs include the National Incident

Management System (NIMS), the California Standardized Emergency Management System (SEMS), municipal fire department IMSs, and the Southern California FIRESCOPE multi-agency coordination system (MACS) for coordinating wildfire firefighting resources. The aim of all IMSs is to rationalize and organize responders while simultaneously enabling the assimilation of pre-planned resources in the response (Perry, 2003).

In order for first responders and emergency management officials to be comfortable with the use of an IMS, it needs to be routinely used for both small and large-scale events. If the IMS is not used routinely, there is a chance of a breakdown in the response due to lack of practice with the IMS. For an IMS to function well, two fundamental principles must be followed. First, the local response structure must be flexible enough to expand readily as additional resources are added to match the level of demands posed by an escalating event. Second, the IMS used to routinely respond to everyday emergencies should form the basis of an expanded structure to deal with disasters (Perry, 2003).

The IMS requires two main data items, a command structure and data about available response resources (personnel, materials, and equipment). An IMS can contain one or more command structures that are tailored to different disaster types. When determining what data needs to be included in the common data set for this disaster data study, previously agreed upon incident command structures and response resources data should be considered. The command structure could also determine what groups performing which functions would have permission to access sensitive disaster data in a disaster database.

Kovel Disaster Database Model

Jacob Kovel of the University of Kansas has proposed a model for a database of information needed before, during, and after a disaster (Kovel, 2000). Kovel's database consists of three parts; a key facilities database, a resources database, and a disaster and emergency database. These three databases exist to assist a disaster management system to identify key facilities that need to be protected or evacuated, the resources (and their locations) available for response operations, and the extent of likely damage to the key facilities.

The key facilities database contains information about the facility type (hospital, city hall, school, etc.), facility location (street address and some universal geographical identifier like a set of coordinates), facility priority level, and a notes section of other pertinent information. The resources database includes the type of resource (dump truck, shelter), the amount of resources available (two trucks, 130 beds), the resource location (address and coordinates), a contact person, their phone number, and any additional pertinent notes. Local officials primarily create the facilities and resources databases.

The disaster/emergency database contains the expected extent of damage due to a quantified disaster threat. The creation of the disaster/emergency database, however, generally requires input from a national damage model (such as HAZUS) to generate the extent of damaged areas based on certain disaster inputs. Kovel suggests integrating all three databases with a Geographic Information System (GIS) to enable local officials to more efficiently analyze and display the information contained in the three databases (Kovel, 2000).

In order for the three databases to be used to prepare for a disaster and respond to it, they must first be created. In most areas, the required information in the three databases is not initially organized so that it can be easily distributed, but is instead collected in an ad hoc manner when a disaster occurs (Kovel, 2000). After the databases have been completed, they can be employed to support planning and disaster response operations. Kovel has proposed a five-step analysis procedure for using the data in the three databases, shown in Figure 4 (Kovel, 2000). The five steps are outlined below.

1. Identify the disasters that will likely affect the area of concern.
2. Develop overlays that will determine the extent and magnitude of damage expected (using models such as HAZUS-MH to create extent of damage database). Choose a disaster magnitude to prepare for based on the area's history.
3. Determine which facilities and systems will likely be affected and the extent of the impact (using facilities database items).
4. Divide the facilities into the mitigation and response lists.
5. Prepare a plan to address those facilities and systems (using the response resources database).

One of the purposes of this disaster data study is to facilitate the collection, organization, and storage of the types of data Kovel includes in his three disaster databases (facilities, resources, and disaster/emergency). This project also seeks to further define what data items, and in what format, would need to be included (in addition to those included by Kovel) in such a disaster database system or repository.

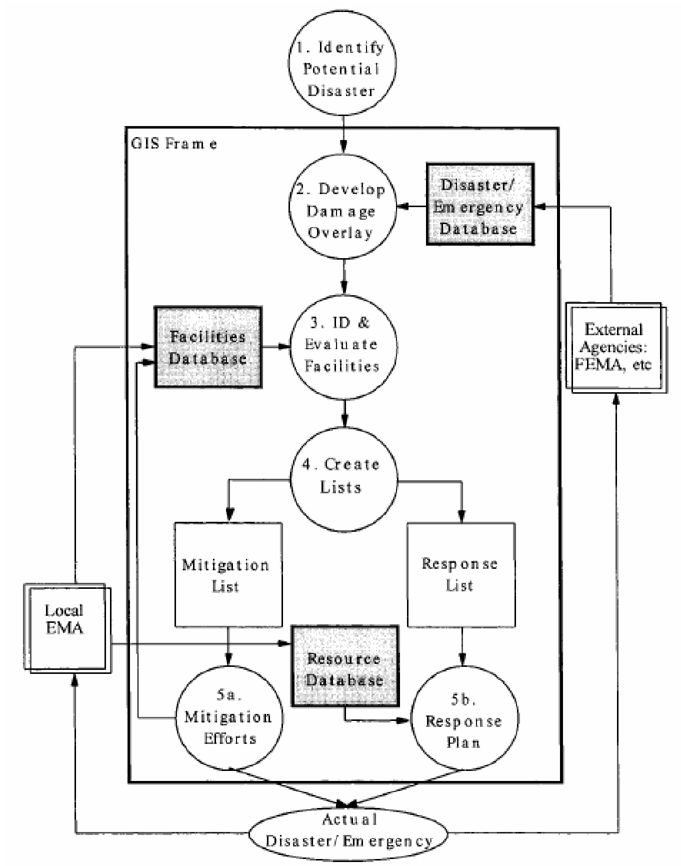

Figure 4. Role of the Three Disaster Databases in the Five Step Data Analysis Process

Southwestern Indiana Disaster Management System

The Southwestern Indiana Disaster Management System (SIDMS) proposes a method of integrating an IMS, disaster databases, and disaster models to allow a decision maker, such as a head of emergency management, to craft highly informed disaster planning and response assessments (Uddin, 2002). The multi-disaster phase SIDMS focuses on two major efforts: simulation, planning, mitigation, and response for disasters; and, improving community awareness and readiness for disasters.

Five vital information needs, (*planning, infrastructure, incentives, communications and coordination, community education, and family values*) supply the information needed by the SIDMS and are shown in Table 3. *Planning* includes information about the likelihood and scope of potential disasters. *Infrastructure* includes information about telecommunications, electric power systems, gas and oil storage and transportation, water supply systems, emergency services, banking and finance, transportation, and continuity of government. The *incentives* information need consists of funding available for disaster preparation and incentives for mitigation compliance. The *communication and coordination* information needs includes plans for more efficient and effective evacuation and shelter use and IMS communication and coordination plans. Finally, the *community education and family values* information needs incorporate increasing community awareness and disaster readiness.

Table 3. Southwestern Indiana DMS Information Needs

Information Needs for Planning 1. Impending disaster likelihood 2. Impending disaster effects 3. Analysis of proactive mitigation measure 4. Mitigation implementation *Information Needs for Infrastructure* 1. Infrastructure asset information 2. Infrastructure functionality 3. Human resources for infrastructure operation 4. Actions after a disaster *Information Needs for Incentives* 1. Funding available 2. Target groups and opportunities for incentives 3. Benefit of the actions promoted by the incentive 4. Compliance	*Information Needs for Community Education and Family Values* 1. Emphasis augmentation 2. Awareness and readiness 3. Improved motivation 4. Disaster education *Information Needs for Communication and Coordination* 1. Agency-to-public communication and coordination 2. Intra-agency communication and coordination 3. Interagency communication and coordination 4. Near-term asset loss minimization

The five information needs detailed in Table 3 feed a shared information repository, a common communication info-structure, and a decision support tool-kit in the SIDMS architecture shown in Figure 5 (Uddin, 2002). These five information needs are grouped together in a box in Figure 5. This box supplies information to the shared information repository, common communication info-structure, and decision support tool-kit in the SIDMS.

The shared information repository is a disaster database in an object-oriented or relational format that is connected securely to the other parts of the SIDMS architecture that request information from the repository. The common communication info-structure interacts with the communications from sensors in the field as well as voice and data communications between emergency management and first responders. The sensors in the field, surveys, and interactive communications between emergency management and first responders populate the data collection box that shares information with the common communication info-structure in Figure 5.

The decision support tool-kit consists of applications that use the data in the repository to promote better disaster management. The most important part of the tool-kit is the disaster simulation model that uses GIS to simulate the extent of disaster damage based on information from the repository. The repository, info-structure, and tool-kit function as the disaster database, IMS, and disaster damage extent model, respectively in the SIDMS and support disaster planning, disaster response, and disaster effect mitigation functions. The decision maker uses the SIDMS to develop disaster response strategies and disaster assessment.

The five information needs outlined in Table 3 are similar to the list of HAZUS-MH data items in Appendix A. However, the difference between the two is that in the SIDMS, no specific data items have been specified. HAZUS-MH, on the other hand, fully specifies their data item set (by what data is actually included with the program). In Table 4, The SIDMS does outline available funding data resources for the incentives information need, but does not list specific data items related to this information need.

Table 4 lists existing data sources for the funding available, target groups and opportunities for incentives, and benefit of the actions promoted by the incentive portions of the incentives information need. The existing data sources listed are the locations where the desired data can be found, but the actual data sets owned by these data sources are not specified. Table 4 also lists the involved decision makers, the value of information, additional data needs, and software and hardware requirements. The authors of the SIDMS do not share data resources tables for the other four information needs listed in Table 3.

In terms of this disaster data study, the SIDMS proposed DMS architecture is informative because it articulates how a disaster data repository can interact with disaster simulation models and incident management communications. The SIDMS also identifies multi-disaster information needs and some data resources, although it does not identify any specific data items to include in a multi-disaster data repository.

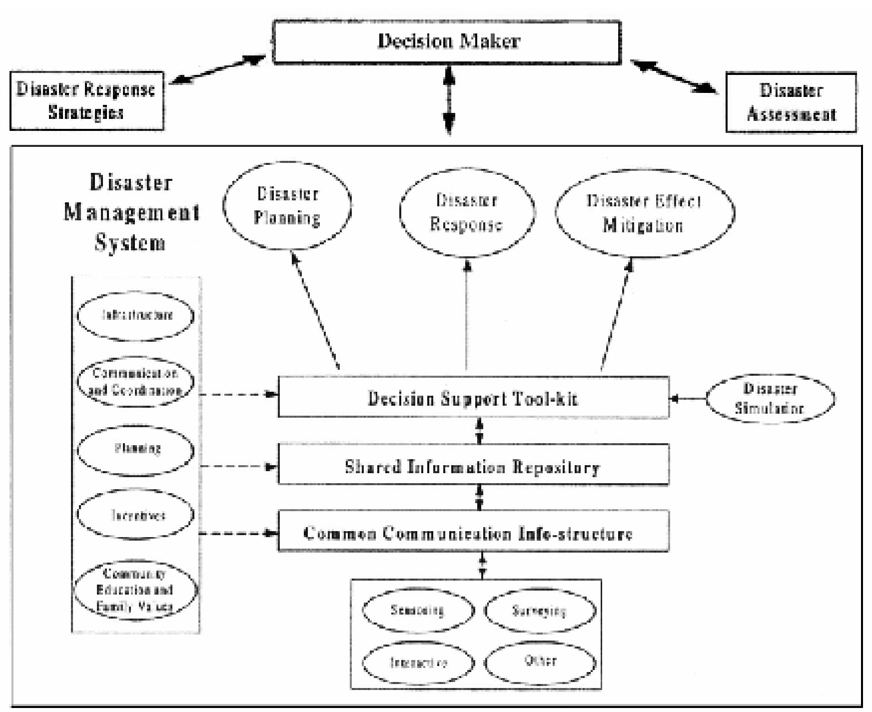

Figure 5. Proposed Architecture for Southwestern Indiana Disaster Management System

Summary

The SIDMS includes and integrates all three parts of a DMS, while the other preceding DMS examples (HAZUS-MH, IMS, Kovel database) illustrate the details of a single part. HAZUS-MH is an example of a disaster damage extent model that could be used in the SIDMS or as the foundation of the disaster damage extent database in the Kovel database model. The Kovel database model, because it includes disaster damage extent information as well as response resources information, emphasizes the necessary interactions between a disaster database and disaster damage models and IMSs.

Table 4. SIDMS Data Resources for Incentives Information Need

Information need	Customer / decision maker	Value of the information	Existing data sources	Additional data needs	Software/ analysis	Hardware	Related capabilities
1. Funding available	Red Cross, local emergency management agencies (EMAs), Disaster Resistant Community Corporation (DRCC), Disaster Recovery Business Alliance (DRBA), universities, schools	Provides the ability to fund incentive programs	DRCC, libraries, community foundations (e.g., Welborn Foundation), Internet, National Science Foundation, Mid-America Earthquake Center, Department of Housing and Urban Development, Indiana Housing Finance Authority, U.S. Environmental Protection Agency (EPA), Department of Justice, Federal Bureau of Investigation, Department of Education	None	Searchable, indexed, and summarized opportunity list	Server for the opportunity list	Federal Emergency Management Agency (FEMA)
2. Target groups and opportunities for incentives	Local EMAs, State Emergency Management Agency (SEMA), DRCC, Red Cross, universities, local government, Chambers of Commerce, DRBA, banks	Increased participation and motivation from all agencies; increased research; increased awareness and preparedness; reduced recovery time for businesses (they can distribute the information to others to improve safety)	Insurance companies, FEMA, institute for Building and Home Safety (IBHS), banks, sociology professors, special needs groups, experience of other communities that have used incentives	Survey to determine incentive opportunities and attitudes, especially based on demographics	Survey tool (potentially the Web) and analysis of the results	Web server for the survey tool, if applicable	None
3. Benefit of the actions promoted by the incentive	Any entity involved in the funding or application of the incentive (e.g., SEMA, FEMA, DRCC, DRBA, Chambers of Commerce, insurance companies, banks, any government agency involved with finding for infractions (EPA, Indiana Department of Environmental Management), city comptrollers, Indiana Regulatory Commission, building commissions	Enables the insurance companies to confidently reduce their rates; benefit to the customer is knowing the reason behind the incentivized action and an under-standing of the reward or penalty	Results (positive and negative) from other communities using incentives	Costs associated with and without the incentive	Financial risk modeling and analysis	Not applicable	None

Data Resources

Disaster data resources, often in the form of data repositories or databases, are needed to support disaster management systems and emergency management decisions. These data resources could have been compiled specifically to enhance disaster preparedness or for other reasons, often economic (loss amounts, inventories). Similarly, the data resource can be targeted for use with a single hazard type or it can be useful in responding to multiple disaster types. Appendix B lists just a sampling of the disaster data resources that exist, as well as information about disaster data resource directories organized by Texas A&M University and EQNet. The following paragraphs will describe the general categories of data resources.

Data resources can be divided into three categories of data resources available during and after a disaster. These categories are as follows:

1. Regularly collected raw information
2. Specifically collected raw information, and
3. Existing functional data from data providers.

Before a disaster, the regularly collected raw information (category 1) and the existing functional data from data providers (category 3) are available. The specifically collected raw information is collected only during and immediately after a disaster occurs.

The first category, regularly collected raw information, includes all raw information (unprocessed) that is regularly collected by organizations or instrumentation. One example of regularly collected raw information is most weather data, such as inches of rainfall or temperature. This information is generally collected by national, state, and local weather agencies. Seismic data collected as part of a regular monitoring program is another example of regularly collected raw information.

Specifically collected raw information includes all raw information that is collected only when there is a disaster. Any individual or organization that has an interest in the disaster's impact collects this raw information. For example, data collection teams comprised of structural experts are deployed during a disaster to determine the extent of damage to structures in the affected area.

The third category, existing functional data from data providers, includes all raw information that was collected in the past and was converted into functional data when it was interpreted and placed into a database. One major data provider is government. For example, municipalities and counties are a resource for cadastral data, and the federal government is a resource for census data. Other data providers include private companies and research organizations.

One method data providers use to facilitate delivery of data to users is a turn-key system. A turn-key system is created when existing functional data from data providers or regularly collected raw data is analyzed and assembled into a database for users to access. The following paragraphs will describe three existing turn-key systems.

CAMEO

Computer-Aided Management of Emergency Operations (CAMEO), is a system of software applications developed by the U.S. Environmental Protection Agency (EPA) that is used to plan for and respond to chemical emergencies (EPA, 2002). The software applications that comprise CAMEO include a chemical database, an air dispersion model, and a mapping capability. The chemical database includes over 6,000 hazardous chemicals and a search engine to access the data. Each chemical entry is linked to chemical-specific information on fire and explosive hazards, health hazards, firefighting techniques, cleanup procedures, and protective clothing. CAMEO also connects users with critical information to identify unknown substances during an incident. First responders, industry, environmental organizations, and emergency management professionals use CAMEO to access, store, and evaluate information critical for developing emergency plans (EPA, 2002).

The disaster type CAMEO is most likely to be used for is a hazardous materials spill in the United States (Table 2). From the perspective of the Kovel three disaster database structure, CAMEO would be included in the disaster/emergency database (Figure 4).

Florida Shelter and Road Status Databases

The Florida Division of Emergency Management (FDEM) on their citizen emergency information website provides a searchable real-time database of shelters and road status (FDEM, 2005). In the shelters database, users can select to view all shelters, all open shelters, all open special needs shelters, and shelter capacity by county. Each shelter entry contains information about shelter capacity, shelter occupancy, shelter status, the shelter's storm surge category, the ability to house special needs individuals, and whether there are showers available on site.

The road status database is similar in appearance and structure to the shelter database and lists road closures by county and whether the road has been re-opened yet. Each road closure entry lists the location of the closure, the road status, when it is estimated to re-open, the road condition, and detailed closure information.

The Florida shelter and road status databases can be used for many of the disaster types shown in Table 2. For example, these databases could be used for hurricane, earthquake, and flood disasters in Florida. From the perspective of the Kovel three disaster database structure, the Florida shelter and road status databases would be included in the facilities database (Figure 4).

Southern California Earthquake Data Center

The Southern California Earthquake Data Center (SCEDC) provides an online database of seismic information from 1932 to the present for the southern California region (SCEDC, 2005). The database can be searched by location, magnitude, time, event ID, polygon (search a geographic area), radius, multi-magnitude, and moment tensors. Each earthquake event entry lists the event ID, magnitude, date, time, earthquake type, location of the earthquake in geographic coordinates, and the depth of the earthquake. Earthquake entries can be output in nine different formats, depending on the purpose of the search.

The SCEDC database is most likely to be used for any of the disaster types in the conflagration disaster factor group in Table 2. The SCEDC database is also limited geographically in its useful scope to Southern California. From the perspective of the Kovel three disaster database structure, the SCEDC database would be included in the disaster/emergency database (Figure 4).

DISASTER DATA RESEARCH BACKGROUND

This study and report focus on the topics of disaster data needs, resources, dissemination, and collection. One group that has done extensive work in the area of earthquake data collection is the Earthquake Engineering Research Institute (EERI), a nonprofit technical society of engineers and other earthquake researchers that works toward reducing the harmful effects of earthquakes through coordinated research. Also, more locally, the North Carolina Institute of Disaster Studies has held a series of workshops on coordinating disaster research between emergency management professionals and faculty within the University of North Carolina (UNC) System.

Earthquake Engineering Research Institute

In 2002, EERI held a workshop entitled *An Action Plan to Develop Earthquake Damage and Loss Protocols* to improve the collection and management of earthquake data (EERI, 2003). This workshop had similar goals to the workshop held at NCSU, including recommendations on how to improve data collection, support data access, and improve data organization and use. For improving data collection, the workshop participants recommended further defining earthquake data needs and a standardized data collection and storage format. Privacy and user access issues, as well as the development of agreements between the business and earthquake research communities, were participant recommendations for supporting data access. For improving data collection and use, the participants recommended establishing a data repository.

In addition to the recommendations developed at the 2002 EERI workshop, EERI has also developed standardized data collection forms for the different types of damage due to earthquakes. Reconnaissance teams, who travel immediately to the earthquake site, collect this data. The reconnaissance teams are formed by researchers completing a standard team member application on which they list their primary areas of expertise and travel preferences.

North Carolina Institute of Disaster Studies

The public University of North Carolina (UNC) system has sought to better coordinate the research efforts of its faculty and institutions with the efforts of emergency management professionals across the state and in local regions. The North Carolina Institute of Disaster Studies (NCIDS) was formed in 2001 by the UNC System based on a recommendation from the NC Disaster Response and Recovery Commission. This commission recommended that the UNC system should facilitate and expand the collaboration between academic researchers in the areas of disaster studies with emergency management professionals and first responding agencies in the state.

The mission of the NCIDS is the "creation of knowledge and transfer of practical intelligence that will mitigate against losses of life and property attributable to disasters of natural, technological, or terrorist origin." To fulfill this mission, the NCIDS has three main purposes (NCIDS, 2004):

1) To facilitate and coordinate research relevant to disaster planning mitigation, response, and recovery;
2) To respond to state or local officials who request training or technical assistance; and,

3) To increase the flow of grant funds from federal, state, or private sources to disaster-related research and training.

Towards this mission, NCIDS held two workshops to identify agenda priorities for the Institute in accordance with their mission and goals. The first workshop, held in 2003 in Greenville, developed action items for NCIDS while the second workshop, which was held in 2004 in Charlotte, discussed public health issues and NCIDS research priorities.

Greenville NCIDS Workshop

The inaugural NCIDS workshop was held May 22-23, 2003 at East Carolina University in Greenville, NC with 78 emergency management professionals and academics in attendance. The goals of the workshop were to develop an agenda for NCIDS, identify the emergency management and homeland security needs of state and local government practitioners, and provide opportunities for collaboration between emergency management practitioners and the UNC university and community college system that would help to reduce the impact of natural and human-induced disasters on NC.

The workshop participants were divided into working groups led by a facilitator who used a common discussion format to lead each workgroup in identifying agenda priorities for NCIDS. From these discussions, common themes, focus areas, and action items were identified. Table 5 lists the focus areas divided into three main program goal areas: Education and Training, Applied and Basic Research, and Communication and Outreach (NCIDS, 2004).

Table 5. NCIDS Focus Areas Identified at the 2003 Greenville Workshop

Education and Training	Applied and Basic Research	Communication and Outreach
Educating NC's Future Emergency Managers	NC Hazards Research Inventory	Develop a Comprehensive Hazards Communication Program for NC
Offer Continuing Education for Emergency Managers	Coordinated and Sustained Applied Research Program	Coordinate and Utilize Existing Outreach Networks
Develop a Continuing Education Program for Elected Officials in NC	Support Needed Basic Research Initiatives	Develop a K-12 Hazards Curriculum and Teaching Resources
	Regional Hazards Research – Quick Response Teams	NC Repository for Hazards Data and Information
	Support for Multidisciplinary Research	

Charlotte NCIDS Workshop

The second NCIDS workshop was held May 20-21, 2004 at the University of North Carolina-Charlotte with 60 emergency management practitioners, academics, students, and public and private sector representatives in attendance. The goals of this workshop were to discuss public health issues as related to disasters and to extend the work of the first workshop in identifying research, funding, and collaboration priorities for NCIDS and the UNC System.

The workshop participants were divided into three breakout groups, one for each of the program goal areas identified in the 2003 Greenville workshop. The group facilitators led a discussion in each of the groups on developing an action plan and a funding strategy for NCIDS in the context of the program goal area for each breakout group. The results of each breakout group's discussions were then presented to the entire workshop group by the breakout group's facilitator.

The Education and Training group identified key issues in their program goal area, including the balance between a focus on emergency response and prevention, surge capacity versus availability, a lack of agricultural and mental health focus, as well as community involvement and a need for expertise at wide levels. The Applied and Basic Research breakout group decided that the process of determining research priorities must be inclusive of all stakeholders and that strategies for addressing organizational challenges must be considered. The Communication and Outreach group determined that developing a NC repository for hazards data and information would be the focus area that would be of highest value and most achievable by NCIDS and that NCIDS should look into holding a forum to discuss the lessons learned from NC disaster responses and to discuss areas in which academics in the UNC system can contribute research (NCIDS, 2004).

North Carolina Emergency Management Division

The North Carolina Emergency Management Division in the North Carolina Department of Crime Control and Public Safety (NCEM) is the state agency responsible for protecting NC from the effects of natural and man-made disasters. Their mission is to enhance the quality of life in NC by assisting people to effectively prepare for, respond to, recover from, and mitigate against all hazards and disasters.

As part of their disaster preparation, mitigation, and response efforts, NCEM needs to be able to collect data about the impacts of a disaster in an organized manner so this data can be utilized in the future for prevention and mitigation efforts. Currently, NCEM receives data from disparate local, state, and federal groups that varies in format and quality. NCEM has a great interest in tapping the expertise of the University of North Carolina system academic community to help NCEM, not only by conducting disaster research but also by fielding data collection teams of faculty and students that could be quickly deployed after a disaster event to collect critical data on the disaster impact. These data collection teams need to be organized in their deployment, data collection, and data dissemination procedures in order for their efforts to be of maximum benefit to NCEM and the greater hazards and disaster community.

North Carolina State University

One research area currently being pursued by the Department of Civil, Construction, and Environmental Engineering at North Carolina State University (NCSU) is the management of critical infrastructure data. This data would be managed through the creation of a GIS-based infrastructure management information system. This infrastructure management information system is called DIsaster Operations, Risk, Abatement, and MAnagement (DIORAMA). DIORAMA is a computer system that helps to manage critical data regarding aspects of the built environment in relation to a disaster event (Pradhan, 2003). The prototype DIORAMA system constructed at NCSU was designed to fully accommodate the multi-phase and multi-event nature of what occurs during a disaster. The prototype DIORAMA system combines GIS with a relational database, photographs, computer-aided design (CAD) drawings, and site reports (Pradhan, 2003).

Within the NCSU DIORAMA system there is a cogent data framework (CDF) that stores and analyses the baseline and damage infrastructure information for multiple disaster events. This framework supports multiple users, facilitates information sharing, secures critical data against unauthorized access, and supports sophisticated spatial queries. For the framework to be considered a cogent framework, it must accommodate a digital depiction of the physical environment, integration of data sets into a single repository, connection of infrastructure features with their attributes, and evolution of the data set over time (Laefer, 2006).

In order to define a cogent data framework, the disaster data needs and resources available for the framework had to be defined, as well as the ways in which disaster data was disseminated between groups involved in the disaster phases. Because the cogent data framework for DIORAMA has to include multiple disasters, the NCSU research focused on finding commonalties in data needs, or a common data set that could comprise the initial CDF for the prototype DIORAMA system (Laefer, 2006). Although disaster events are highly distinct in their nature, intensity, location, and timing, many share commonalties related to the data sets required to address these disasters in a multi-phase, multi-event context.

For instance, evacuation may be a required process during earthquakes, hurricanes, forest fires, and nuclear contamination. To find proper evacuation routes, the same road network data set is required, irrespective of the disaster. Still, some data sets are pertinent to only specific disasters (Figure 6). Flooding requires elevation data to establish water heights at specific times for particular locations. In contrast, building collapses require foundation information. Thus, all relevant data sets (both common and disaster-specific) must be integrated into one common repository system to fully manage disasters (Laefer, 2006). Defining the relevant common and disaster-specific data sets is the next step towards creating a common data repository to support DIORAMA.

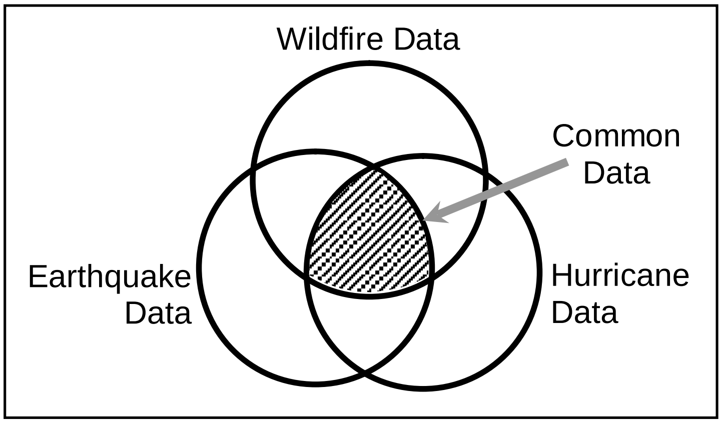

Figure 6. Illustration of Common Data Sets

Case for 2004 NCSU Disaster Data Workshop

Based on the data collection and dissemination issues raised by NCIDS, NCSU, and NCEM, it was determined that there was a need to gather members of the academic and emergency management communities together to obtain a more accurate picture of multi-disaster data collection, and to develop the foundation of a consensus on areas of disaster data management that needed improvement in NC. A workshop, instead of a series of meetings with individuals or groups, was chosen as the best way to address the data collection and dissemination issues. Within the workshop it was felt that there could be dialogue not only between the interested parties and the emergency management community, but also within the academic and emergency management communities.

In order to facilitate the development in NC of a disaster data management plan, NCSU offered to host a workshop comprising local public and private disaster management professionals, state and national experts, and academics on November 4-5, 2004 in Raleigh, NC. At this workshop, strategies for better data collection, data sharing, data dissemination, and pre-disaster coordination of disaster response teams for the Triangle region would be developed. It was hoped that the structure and results of the workshop would serve as a model for other local communities to develop better disaster data management plans. The workshop was envisioned to serve as a guide for other states and the federal government and as a possible tool to use to encourage better disaster preparation and management nationwide.

In the spring of 2004 a planning committee for the workshop containing members of NCSU, NCIDS, and NCEM, was formed to plan the workshop. The members of the workshop planning committee are listed in Appendix C. The workshop planning committee outlined the scope and objectives of the workshop, (listed in the following section) as well as the workshop agenda and speakers. The committee also sent out a letter of invitation, included in Appendix D, to encourage NC emergency management professionals and disaster researchers to attend.

WORKSHOP SCOPE AND OBJECTIVES

In developing the workshop's scope, the planning committee considered both disasters that regularly occur in NC as well as disasters that were low probability but high impact events. The disaster types that would be investigated were chosen from the disaster types list in Table 2. The set of workshop objectives developed by the workshop planning committee were selected based on the pressing research needs of NCIDS, NCEM, and NCSU.

Workshop Scope

Recent terrorist attacks, along with devastating hurricane seasons have heightened awareness within the academic and emergency management communities on the importance of continually improving disaster preparation, response, and recovery in the United States. States and municipalities that previously considered natural and accidental man-made disasters in their emergency management plans now had to develop protocols for terrorist attacks. Terrorists often use bombs or other explosive material that cause extensive human casualties and damage to infrastructure within the limited area of the explosion. Because the planners of the NCSU workshop wanted to include a terrorist disaster and had an interest in disasters that impact infrastructure, an intentional high explosive device detonation was identified as a disaster to be considered by the NCSU workshop participants. Thus, one chosen disaster was an intentional explosion.

Natural disaster research and response are a priority in the state of NC because the state's geographic location makes it vulnerable on an annual basis to hurricanes and ice storms. Hurricanes have caused wide-spread damage, including landslides, flooding, beach erosion, utility service interruption, and structural wind damage to all regions of the state, but primarily in the coastal east and along the Outer Banks. Because of the multiple ways a hurricane can damage a region, hurricanes were separated into separate wind and flood disasters. This enabled the workshop participants to focus their discussion on the different data management issues for each disaster factor. Also, by considering wind and flood disasters separately, the participant discussion could be relevant to tornado, thunderstorm, and heavy rain disasters. Thus, hurricane and tornado winds and floods were chosen as the second and third focus areas for the workshop.

Ice storms also commonly strike NC during the winter months. Nearly every winter at least one storm coats all surfaces with at least ¼" of ice. This generally occurs in the central Piedmont region of the state because of the unique climate conditions in this region. Ice storms often cause extensive power loss and cripple transportation in the localized region where the heavy ice is deposited. Because ice storms are a nearly annual disaster event that greatly disrupts the state, the NCSU workshop considered ice storms as the fourth disaster area to focus discussion on.

Other natural disasters, such as earthquakes, tornadoes, and wildfire occur less frequently in NC and usually on a much smaller scale resulting in only minor, localized damage. Earthquakes powerful enough to cause damage to infrastructure affect NC every 250-400 years. Man-made disasters, such as accidental explosions and chemical spills, occur usually in industrial or commercial locations or along major highways. Because these other natural and man-made disasters usually only affect a small group of people or neighborhood, because they occur infrequently, and because they are limited in extent rather than covering an entire region, they were not included in the scope of the NCSU workshop.

Because the workshop was only planned to last for a day and a half, the planning committee determined that four different disasters was the most a group of approximately 30-40 participants could discuss in-depth. The four disasters chosen by the workshop planning committee to discuss in the workshop were:

- Hurricane and Tornado Wind,
- Flood,
- Ice Storm, and
- Intentional Explosion.

These four disasters will be referred to as wind, flood, ice, and explosion in the rest of this report. The four disasters, wind, flood, ice, and explosion, would serve both as the most frequent probable natural and man-made disasters in NC and as the multiple disasters to be used to preliminarily define the common data set for a disaster data repository. The disaster types chosen for the workshop are shaded in Table 2.

Workshop Objectives

The workshop objectives sought to address the disaster data research needs of NCIDS, NCEM, and NCSU within the above described framework. The five chosen objectives for the workshop were as follows:

1. Evaluate the applicability of a general multi-disaster model,
2. Understand local data needs and opportunities,
3. Establish clear models of organizational participation in collection and use,
4. Define a common data set for multiple disasters, and
5. Lay the groundwork for establishment of data collection teams.

For NCIDS, several of the goals of and findings from the Greenville and Charlotte workshops partially motivated the development of objectives 2, 3, 4, and 5 for the NCSU 2004 workshop. The Greenville workshop's goals of identifying both emergency management needs and collaboration opportunities translated into the focus on identifying data needs and determining ways to better structure data collection teams and how to better achieve data dissemination at the NCSU workshop.

The NCSU workshop also sought to address two focus areas formulated at the NCIDS Greenville workshop, the NC repository for hazards data and quick response teams. This was done by addressing the basic contents of a repository and by continuing the progress towards the development of data collection teams. The 2004 Charlotte workshop findings also emphasized the need for the creation of a disaster data repository.

NCEM's main interest in the workshop was in objective 5, laying the groundwork for establishing data collection teams. NCEM wanted to engage the workshop participants in a discussion on the issues related to forming these teams as well as encouraging the workshop participants to serve as team leaders and participants. NCEM also has a secondary interest in objective 4, defining a common data set, because this would aid in the pre-disaster event development of a disaster data repository, which could aid NCEM's long-range disaster minimization efforts.

A major motivation for objective 1, evaluating the applicability of a general multi-disaster model, developed from NCSU's research on creating the model framework for DIORAMA. The workshop provided an opportunity to test the multi-disaster data models being developed at NCSU. Meeting objectives 2 and 3 would facilitate the completion of objective 4, the definition of a common data set, which would then serve as the fundamental database for the construction of the NCSU DIORAMA system.

WORKSHOP STRUCTURE

The structure of the November 2004 NCSU Disaster Data Workshop was based on meeting the five workshop objectives with the 1.5-day span of the workshop. The five sessions of the workshop were as follows.

1. Data Needs,
2. Data Resources,
3. Data Dissemination,
4. Common Data Set, and
5. Data Collection Teams.

The goal of each session was to satisfy one or more of the workshop objectives. Table 6 charts the specific relationships between the workshop sessions and the workshop objectives. The data needs session fulfilled the second objective of understanding local data needs and opportunities, while the data resources session helps to define what data needs are data opportunities, i.e. the data has yet to be collected. The data dissemination session, along with the data resources session, helped to meet the objective of establishing clear models of organizational participation in data collection and use. The common data set session met the fourth workshop objective of defining a common data set for multiple disasters. Finally, the data collection teams session was set up to determine how to create teams to perform field data collection activities. The first four sessions helped to determine what data to collect and to evaluate the applicability of a general multi-disaster model (first workshop objective), while the data collection teams session assisted in determining who would collect that data.

Table 6. Workshop Structure and Objectives

WORKSHOP OBJECTIVES / WORKSHOP SESSIONS		1	2	3	4	5
		Evaluate the applicability of a general multi-disaster model	Understand local data needs and opportunities	Establish clear models of organizational participation	Define a common data set for multiple disasters	Lay groundwork for establishment of data collection teams
A	Data Needs	X	X			
B	Data Resources	X	X	X		
C	Data Dissemination	X		X		
D	Common Data Set	X			X	
E	Data Collection Teams					X

Table 7 illustrates the basic structure of each of the five sessions just described. The workshop participants were divided equally into four breakout groups, one for each of the four disasters (wind, ice, flood, and explosion) determined by the workshop planning committee to be within the workshop's scope. Each group was led by at least one facilitator who was chosen to lead the group based on their professional experience with the selected disaster. For example, Tim Johnson, who professionally often works with flood mapping, led the flood disaster group. The assignment of workshop participants to breakout groups also followed this idea, so that the majority of the climate experts were placed in the wind group and similarly, the fire-fighting professionals were assigned to the explosion group. The breakout groups were used for the first four sessions, with the data collection session involving all workshop participants collectively. The facilitator and members of each breakout group are listed in Appendices C and E.

Table 7. Outline of Workshop Structure

				Groups Determining for each Disaster				
	Workshop Session	Tasks/Questions to Answer	Total Time (min)	Earthquake	High Winds	Ice Storm	Explosion	Flood
Thursday	Data Needs	Modify Earthquake Model What are the data needs? Who is involved? Where collect? When collect? What is the data format?	90	Modify to Reflect NC	Yellow Group	Green Group	Red Group	Blue Group
Thursday	Data Resources	Modify Earthquake Model What are the data resources? Who is involved? Where collected? When collected? What is the data format?	90	Modify to Reflect NC	Yellow Group	Green Group	Blue Group	Red Group
Thursday	Dissemination	Modify Earthquake Model What data is disseminated? Who is involved? What is the transfer method? When disseminated? What is the data format?	75	Modify to Reflect NC	Yellow Group	Green Group	Blue Group	Red Group
Friday	Common Data Set	What data is commonly needed? What data should be inlcuded in clearinghouse?	75	All Groups Determine for All Disasters, Using Four Areas Model				
Friday	Data Collection Teams	Who should be on team? What are the collection priorities?	70	Large Group Discussion				

The first three sessions, data needs, resources, and dissemination, were held the first day of the workshop, Thursday November 4, as shown on the workshop agenda (Appendix F). Each of these three sessions had a similar structure. Once the breakout group had assembled, the group was introduced to the multi-disaster data model, which was created to facilitate and focus each breakout group's discussion. The multi-disaster data model, which is found in Appendix G, listed 31 different data categories, split between inventory data (compiled prior to disaster event) and damage data (compiled during and after event). Each facilitator was instructed to use the model's categories to encourage focused and comprehensive discussion about data needs, resources, and dissemination within the group, with the understanding that some categories would not be as applicable in certain situations as others. The participants were also given a participant information sheet (Appendix H) that outlined the procedure for the workshop session discussions.

Each group was given 31 discussion response sheets, one for each category (Appendix I). Each sheet contained separate spaces to record the groups' discussion of data needs, resources, and dissemination. There were spaces to put the *who*, *what*, *when*, *where*, and *in what format* for each model category. A sample discussion response form (Appendix J already filled out for an earthquake disaster in the damage data-buildings category) was provided to each group as an example response.

Initially, it was expected that the groups would critique the sample discussion response form, but the breakout groups tended to use the sample form only as an example. When the sample form was introduced, each breakout group then progressed through the categories in their own way. Some groups followed the format of the discussion response forms that were provided and filled them in, while others offered less structured, but still valuable responses. At the end of each breakout session on Thursday, all four groups gathered together and each group facilitator presented a summary of the group's findings about their disaster's data needs, resources, and dissemination issues. The purpose of this was encourage sharing of each group's findings with the other participants and to gather comments from participants who were not in the facilitator's group. In addition to the sessions on Thursday, R. Jay Love, representing EERI, gave a presentation to all participants about EERI's Learning From Earthquakes program (Appendix K).

Using the summary information from each facilitator, a new Four Areas Disaster Data Model was developed to better enable the groups to discuss common data sets across multiple disasters during the first session on Friday morning. The Four Areas Disaster Data Model is further discussed in the Results chapter of this report. The four breakout groups were instructed to place the common data sets they identified into one of four areas. The four data areas were hazard, infrastructure, population, and physical resources. At the end of the first breakout session of the day on Friday, the groups gathered together to present and discuss the results of the common data set exercise.

The second session on Friday, which was the final session of the workshop, began with a presentation by Dr. Ken Taylor, Director of NCEM, on forming Data Collection Teams for NC. Next, Dr. Taylor led a discussion with the workshop participants to gain their insight into how to best form and support the data collection teams. The workshop participants also completed data collection team forms from EERI (Appendix L) listing their areas of expertise and any special skills they might possess.

WORKSHOP FINDINGS

A summary of the findings from each of the four workshop groups is given below. Each group was assigned a different disaster to evaluate using the multi-disaster data model outlined in Appendix G. Each group's findings on disaster data needs and resources are summarized in four areas: hazard, infrastructure, population, and response resources. Each group's ideas about data dissemination for their assigned disaster are also included.

Wind Group

The facilitators for the wind group were R. Jay Love and Dr. Stephen Meinhold. Appendix E lists the members of this group, which evaluated the multi-disaster data model for a wind event (i.e. hurricane winds, tornado, etc.), considering only the effects of wind, not water.

Hazard

The wind group determined the data needs and resources required before, during, and after a storm with high winds. Before a wind storm hits, the group determined that it is important to maintain a historical wind data resource. The historical wind data should include the past speed, direction, and duration of wind storms and the impact these storms had on people, property, and industry in the area. Surge zone maps would also be useful.

During a wind event, real-time data on wind speed and direction at multiple ground locations and in multiple levels of the atmosphere is needed. This information should contain both the sustained and gusting wind speeds, and ideally would be available in an electronic database format. Current esources for the wind data include the National Weather Services branches in and around NC, the State Climate Office, the National Severe Storms Laboratory, the National Climatic Data Center, the HurrEvac program, and the National Center for Atmospheric Research.

After the wind event, the significant data about the characteristics of the wind event should be archived for research towards mitigating the effects of future storms. Also, the extent of the area impacted and the level of damage should be well documented.

Infrastructure

Next, the wind group determined the data needs and resources for information about infrastructure for before, during, and after a wind storm event. Before the wind storm, the local government should have organized cadastral data, ideally in electronic form, that document the location and value of property in the area. Also needed is the location and capacity of roads, and locations of critical businesses, hospitals, senior centers, schools and agricultural operations.

During the event, real-time or preliminary information on the extent of damage to structures and roads, especially roads that are closed, is critical to guiding the response to the wind event, particularly rescue operations and damage assessment. When the wind storm has passed, a final damage survey of structures is needed for planning and insurance purposes. The damage should be quantified for each structure and an estimate of residential and business damage should be made. The interruption to business, tourism, and agricultural operations caused by the storm should also be quantified. Any changes to the built landscape due to the storm and the subsequent infrastructure reconstruction should be documented.

Population

For a wind event, the group identified the data needs and resources for population data. The primary source for population data prior to a wind event is census information about population demographics and population density in the affected communities. Of most interest are the size and characteristics of the vulnerable populations, such as the old and disabled. A geographic information system (GIS) based database of the geographical distribution of vulnerable individuals aggregated to the census block level would help to facilitate evacuation planning. Also aiding in evacuation planning is knowledge of the tourists or seasonal visitors, prison, and mental institution populations. During the wind event, emergency management professionals need to know approximately the size of the exposed population as well as the total number of people evacuated and in shelters.

Response Resources

Prior to a wind event, the emergency managers, along with other groups (such as the Army Corps of Engineers and FEMA) create an evacuation plan to outline the responder needs and coordinate the population movement away from the hazard. During the event, the status of the evacuation route is a critical item of information for responders. It is also helpful to obtain (from the North Carolina Department of Transportation (NCDOT)) the typical vehicle traffic counts at critical intersections and any road closures.

Data Dissemination

Data dissemination during all stages of a wind event is critical to the emergency response. Emergency managers need quick access to reports, academic papers, visual displays, and GIS-based data and maps. The group identified GIS as an ideal format for event information, with metadata following standards developed by the Federal Geographic Data Committee (FGDC). The data collected and disseminated should also be time referenced, i.e. containing a time stamp.

Information during a wind event needs to be disseminated from emergency managers and weather services to the general public to help them prepare. Generally, information about the location and time of arrival of a wind event is delivered to the public via television, radio, and the internet. Wind event information also needs to be disseminated to researchers after the event so that it can be entered into traditional or spatial databases to create new data sets to be used in research analysis. The group also identified libraries as a critical tool for collecting and archiving wind event data. The collection and recording of successful efforts to mitigate the effects of the disaster was also identified as being important to future mitigation and research efforts.

Ice Storm Group

The ice storm group facilitator was Dr. Gavin Smith. Appendix E lists the members of this group, who evaluated the multi-disaster data model for a winter ice storm event, with a focus on the effects of ice.

Hazard

The ice storm group determined the required data needs and resources before, during, and after an ice storm. The primary hazard-related data concerns weather conditions, such as ice thickness, temperature, and storm location. This group named the NC State Climate Office as a very important resource for weather data. Before the storm, historical information about previous damage caused by similar storms is important to response planning during the mitigation disaster cycle phase. During and after the ice storm, information about the damages caused by the current storm is needed to coordinate the response and to draw lessons in preparation for future storm events.

Infrastructure

During an ice storm, information about infrastructure is needed to guide the emergency response. The workshop participants in the ice storm group mainly addressed the infrastructure data needs during an event, and not before or after. Usually, the primary focus during an ice event is restoring power service to critical facilities and returning the road network to regular operation. Information is needed on who owns the power grid that needs to be restored, the location and availability of backup power sources for critical facilities (e.g. hospitals, emergency operations centers), when and where power will be restored, location of power company personnel, access routes to areas that need repair, and historical data on the duration and location of previous outages. The group mentioned that often power company data is not made available to public responding agencies, and that this data is not well coordinated due to the multiple power companies operating in the affected area.

The group identified the status of the road network as being another critical data need. Prior to an event, NCDOT and municipalities develop snow removal plans and policies. During the event, information on road closures from the NCDOT and municipalities is critical to the public and to the power companies attempting to restore power. Fallen trees often cause road closures, so information about the location and number of fallen trees and the crews available to remove them becomes an important data item. Other transportation information, such as airport closures, also is needed from the airport authorities so the public does not unnecessarily travel to the airport experiencing the icy conditions.

Population

The population data needs and resources during an ice storm include census and demographic data from the federal government, as well as local data about the cultural and language needs of the population. The number and spatial location of special needs individuals to a power outage (such as the elderly, economically disadvantaged, and ill) need to be obtained from local government sources so that they can be relocated to heated shelters if necessary. The number of relocated individuals can be obtained from the sheltering agency, such as the state government or the Red Cross.

The operations of health care centers are also impacted by an ice storm. These critical facilities need current transportation information from the NCDOT and municipalities to coordinate the transportation of personnel and patients to and from the facility. Health care facilities and first responders are a resource for the number and status of individuals injured by the storm.

Response Resources

There were several data needs and resources identified by the ice storm group with respect to aiding in the coordination of response resources. Information about the location, members, duties, and abilities of special teams, such as EMS, law enforcement, snow and ice removal, and wildlife control is necessary for emergency management to deploy these groups properly. Responders also need to know the location and extent of damage in the area affected by the ice storm.

Setting up and managing shelters for displaced individuals also requires data. The shelter managers, who can be from a non-profit organization such as the Red Cross or from the government need to coordinate the transportation of people, relief food, and supplies to and from the shelters. They also need heaters or other backup generated power set up for them and a system to manage any donations that are provided by the community. The shelter also needs a list of individuals who are trained as shelter volunteers to keep the shelter properly operating. The ice storm group emphasized that there is a need to study ice storm disasters in more detail, because NC is especially prone to these winter events.

Data Dissemination

Dissemination of data during all stages of an ice storm event is critical to the emergency response. Weather, power, road, population, and health data is collected before, during, and after the ice storm. This data is usually in the form of reports or press releases, and may or may not be geospatially defined. Weather, power, and road information is often communicated to the public via the English and Spanish language media (television, radio, internet), which can be a challenge if the power is unavailable. The 511 phone system and NC Smartlink website are programs of the NCDOT that are used to disseminate road condition information to the public. Radio is also used in the field for emergency managers to communicate with response personnel. The EM2000 computer program also helps emergency managers and other agencies share data with each other during the ice storm.

Flood Group

The flood group facilitator was Tim Johnson. Appendix E lists the members of this group, which evaluated the multi-disaster data model for a flood disaster.

Hazard

The flood storm group identified the required data needs and resources for floods. The group identified the depth and location of flood waters as the critical data that must be obtained for flood events. This would include the locations and depths of flooded areas, especially flooded transportation avenues, such as roads, which would hinder access to and evacuation from the flooded zone.

Infrastructure

The flood group identified the data needs and resources necessary to determine the status of the built environment in a flood zone. The group felt that basic inventory data of buildings and other critical facilities as well as the elements of the highway transportation system (roads, bridges, tunnels) has already been well documented by local and state governments in NC. The location and basic attributes of buildings, roads, and tunnels is needed during flooding, as well as the locations, elevations, and status of water and sewer systems. For buildings, attributes would include building footprints, property boundaries, finished floor elevations, and structural building types.

The group identified local government tax assessors, and HUD post-disaster inspections as resources for building data. Digital representations of building data, including pictures, were identified as the ideal format for ongoing collection of building data. Data resources for the extent and status of the road network include the NCDOT, local government, and regional media sources. Local governments are also the primary resources for information about local water and sewer systems. The North Carolina Rural Economic Development Center is working on their Water2030 initiative, updating an inventory of water and sewer data for all 100 counties in NC (NCREDC, 2004).

The group identified that for the power systems in the Triangle area and in NC, there was no system-wide common communications with local and state governments. Each power company holds the information about their system, and sharing of power status is difficult. Besides the power companies themselves, information about power outages due to floods can also be obtained from the fire department, EMS services, and local citizens and government.

Population

The flood storm group also identified population data needs and resources in a flood zone. The group felt that basic inventory demographic data about the population has already been well documented by local and state governments in NC, and by the federal census. The flood group mentioned that the census has been known to underreport certain populations, such as Hispanic, in the state. Population data needed includes school population, prison population, and temporary residents (college students, tourists). Resources for population data include the state demographer, the UNC Carolina Population Center, the department of corrections, and local school districts (UNC, 2005).

The North Carolina State Department of Health and Human Services was identified by the group as a resource for information about vulnerable populations as well as the number of people affected by, injured by, and killed by the flooding. The group named the North Carolina Small Business Adminstration, local chambers of commerce, and the Business Continuity Planners of the Carolinas as resources for information about businesses displaced by floods. Information about the animals impacted, injured, and displaced by the flood can be obtained from the agriculture department, state animal response, the North Carolina Wildlife Resources Commission, and the swift water rescue teams.

Response Resources

The flood group also identified response data resources for a flood disaster. Data resources include regional response teams, local and state emergency management, law enforcement, fire departments, and rescue units.

Data Dissemination

The flood group discussed the primary organizations that disseminate flood disaster data and the data types that are disseminated. Identified organizations included local governments, state governments, the federal government, non-profits, universities, and the private sector.

The data types listed by the group as being disseminated by local governments include evacuation details, blocked road locations, shelter status, immediate damage assessment, injuries and deaths, and the tax assessor building inventory. This information is disseminated starting immediately after the disaster to the state government and other local governments via telecommunications, the internet, and the EM2000 computer program (SDS, 2005). The format of this data may be verbal, text on paper, electronic databases, or photographs.

The State government departments of Environment and Natural Resources (DENR), Transportation (NCDOT), Agriculture, and Crime Control and Public Safety (which oversees emergency management) disseminate flood related disaster data to local governments, citizens, researchers, and the federal government. The federal government (via the National Weather Service, the United States Geological Survey (USGS), and the Federal Emergency Management Agency) disseminates flood disaster data to local governments, state governments, and non-profit organizations such as the Red Cross. Federal and state flood disaster data is also disseminated via telecommunications, the Internet, and the EM2000 computer program.

Non-profit organizations responding to a flood emergency, such as the Red Cross, disseminate information to the media and various levels of government about what services they are providing (such as shelters or food assistance), how many people they are providing services to, and how many people they believe are still in need of services. The flood group mentioned that non-profit groups tend to be involved in the data dissemination process for a short time, typically during and immediately after providing services.

Universities use their cooperative extensions to disseminate flood information to the public. Results of research are included in research reports sent to the sponsoring agencies and to professional research publications. The flood group stated that data from disaster research at universities is not necessarily funneled down to local governments. The group wanted more investigation into how and what university disaster research can be produced to help local governments and others in practical ways.

In the private sector, power companies, such as Duke Energy and Progress Energy, disseminate critical information to local governments and the media. The critical information disseminated by power companies includes the availability of generators, the number of outages, locations of outages, and estimates of when power will be restored.

Explosion Group

The explosion group facilitator was Dr. Debra Laefer. Appendix E lists the members of this group, which evaluated the multi-disaster data model for an intentional explosion disaster.

Hazard

The explosion group felt that specific data about an explosive detonation was critical to determining a proper response. One important data need is the type of explosive used as well as its size. The type of explosive changes the extent of the damage and the potential hazard to the rescuers involved. The location and characteristics of the target also have a determining effect on the response. For example, the response to the bombing of a bus is different than the response to the bombing of a bridge or a school, because of issues such as site accessibility, traffic, and people. Data collection after an explosion can be complicated by the fact that the area may or may not be a crime scene (depending on whether the explosion was intentional or accidental), restricting access to the site.

Infrastructure

The explosion group identified many data needs for infrastructure in an explosion event because infrastructure is often the target of or is indirectly involved in explosive attacks. For buildings involved in an explosion event, data needs include floor plans, building use, building construction type, fire ratings, stairwell locations, fire escape locations, standpipe locations, probable building occupancy, and a description of building damage. For roads, bridges, and tunnels in or near an explosion, the group identified the data needs and resources for the emergency response. Information about road detours, congestion, the road network, road capacity, and construction closures is needed, as well as the location, size, orientation, capacity, and purpose of bridges and tunnels.

The group also mentioned data needs for utilities, such as power, water, sewer, and telecommunication services. Near an explosion, data needs about the water and sewer system include location of pipes, pipe capacity, interconnects, depth of burial, pipe type, cutoff locations, and the location of any breakages. For power services, the data needs are the location of any outages, portions of the transmission and distribution network affected, the population affected, and any critical facilities affected. Data needs about the telecommunication system include the present footprint of the telecommunication services, system capabilities, interoperability with other providers, and the extent of service outage.

Data resources for building information includes tax records, floor plan drawings, local building inspectors, the Department of Insurance, the Fire Prevention Bureau's three-year inspections, certificates of occupancy, State fire department inspection records, State property office records, County Fire Marshall, insurance companies, banks, and planning and zoning commissions. Resources for road, tunnel, and bridge data include the NCDOT, the Federal Highway Administration (FHWA), the North Carolina Center for Geographic Information and Analysis (CGIA), municipalities, and the federal Department of Commerce.

Data resources for utility information include local, state, and federal government agencies, as well as the private sector. The local government utilities, State Utilities Commission, State Department of Environment and Natural Resources, the United States Environment Protection Agency, the USGS, the Federal Communications Commission, the Army Corps of Engineers, and private utility companies are all resources for utility data.

Population

After an explosion, there are many data needs about the population affected by the explosion to ensure their health and safety. These needs include existing evacuation plans, pre-incident plans, and the number of evacuated people, as well as information about the injured or dead, including type and severity of injury, whether the injured is ambulatory, and the locations where people were injured or killed.

In order to treat the injured effectively, emergency responders also need information about health facilities. Data needs about health facilities include location, size, number of beds, availability of utility backup, rapid transport capabilities, access routes, size of burn treatment unit, and medical volunteer network.

Resources for population data include the census, the Department of Motor Vehicles, voter registration information, university enrollment, the HAZUS-MH computer program, the CGIA, utility companies, county health departments, state libraries, public schools, hospitals, EMS personnel, the Red Cross and other non-profit groups, and local law enforcement.

Response Resources

During and right after an explosion event, information about the availability and capability of response resources, such as personnel, shelters, and equipment is needed. The explosion group identified hazardous materials experts, bomb squad, Alcohol Tobacco and Firearms (ATF) officers, Federal Bureau of Investigation (FBI) officers, law enforcement, fire departments, search and rescue teams, and structural engineering specialists as personnel potentially involved in the response to an explosion. Other response resource data needed includes the capacity and location of shelters, and the amount of resources, such as beds, blankets, medical supplies, water, and food available in warehouses for the emergency response. The North Carolina Emergency Management division, as well as the National Guard are data resources for information about supplies available for explosion disaster response.

Data Dissemination

The explosion group noted that there is often relatively little information disseminated to responders at the scene of an explosion event. Most of the information that they do receive is in the form of paper or verbal information or instructions. The group also noted that it is very difficult to verify information during the response and often there is too much information or there are redundancies in information at the scene. The media also plays an important role of notifying the public of evacuation routes and alternative routes for transportation as the events unfurl extremely quickly compared to natural hazards disasters. Research on explosions was noted by the group as being difficult to acquire because each agency keeps their own records and databases detailing what happened during an emergency, and this data is not archived in a manner that information about each event can be easily disseminated in the future. Furthermore, it comes in a variety of formats including documents, pictures, reports, and plans and drawings.

Internet Contacts

The workshop participants mentioned several organizations and software packages as being useful for disaster management and obtaining disaster data. Table 8 lists the names of NC and national organizations and disaster management software packages referred to in the group discussions.

Table 8. Internet Contacts for Organizations Mentioned by Workshop Participants

	Name	Website
North Carolina	NC Smartlink and 511	www.ncsmartlink.org
	State Climate Office	www.nc-climate.ncsu.edu
	NCDOT	www.ncdot.org
	NC Rural Economic Development Center	www.ncruralcenter.org
	UNC Carolina Population Center	www.cpc.unc.edu
	Department of Health and Human Services	www.dhhs.state.nc.us
	NC Small Business Administration	http://www.sba.gov/nc
	Business Continuity Planners of the Carolinas	http://www.drj.com/groups/bcpc
	Department of Environment and Natural Resources	http://www.enr.state.nc.us
	Department of Insurance	http://www.ncdoi.com
	NC Center for Geographic Information and Analysis	cgia.cgia.state.nc.us/cgia
	Utilities Commission	www.ncuc.commerce.state.nc.us
National	National Weather Service	www.nws.noaa.gov
	National Severe Storms Laboratory	www.nssl.noaa.gov
	National Climatic Data Center	www.ncdc.noaa.gov
	National Center for Atmospheric Research	www.ncar.ucar.edu
	Army Corps of Engineers	www.usace.army.mil
	Federal Geographic Data Committee	www.fgdc.gov
	United States Geological Survey	www.usgs.gov
	Federal Highway Administration	www.fhwa.dot.gov

	Name	Website
	Department of Commerce	www.commerce.gov
	Environment Protection Agency	www.epa.gov
	Federal Communications Commission	www.fcc.gov
	Census Bureau	www.census.gov
Disaster Management Software	EM 2000	www.em2000.com
	HAZUS-MH	www.fema.gov/hazus
	HurrEvac	www.hurrevac.com

DISASTER DATA MANAGEMENT POLICY ISSUES

During the first workshop session held on the second day (Friday), the participants in their small groups discussed generally how to best manage disaster data, especially the data items common to multiple disaster types. Disaster data management consists of collecting data, placing the data in the needed format, and then disseminating and maintaining the data. The disaster data management issues identified by the workshop participants are summarized into four areas: data collection, data format, data dissemination, and data maintenance.

Data Collection Issues

The key issues identified in the workshop with respect to data collection were as follows.

- The safety of data collection teams,
- Clearly identifying the benefits of participation in data collection to localities,
- Creating standard data collection procedures and forms,
- Identifying the critical data items to be collected, and
- Post-disaster analysis of data collection efforts.

The workshop participants identified several priorities in disaster data collection. First of all, the security and safety of those affected by a disaster as well as the data collection team(s) is more important than the secondary effort of data collection. Reaching out to local groups is needed to ensure their successful participation in data collection. This involves clearly identifying the benefits of participation to localities and keeping all local stakeholders informed and involved. Workshop participants identified understanding the time sequence of disaster-causing events as helping to predict disaster location and magnitude. One example given in the workshop sessions was local knowledge that if a rain gauge's data indicated that the rainfall rate is 2 inches per hour a nearby campsite would flood. The need for post-event analysis of both what happened in the disaster event and data collection procedures were also identified as a priority by the workshop participants.

The main issue identified as being critical in the data collection procedure by the workshop participants was that there needs to be standard operating guidelines for each event for which data will be collected. Procedures for coordination of data collection efforts between federal, state, and local agencies and data collection teams should be developed and standardized. Ideally, the data collection teams will collect broader data when they first arrive at a disaster-affected area. The results of this first data collection phase will be used to decide where to focus more specific data collection efforts in the second phase. This sequence of data collection team deployment is further discussed in the Team Types section of the next chapter. Workshop participants emphasized that proper and ongoing training would be needed for the disaster data collection teams.

The workshop participants discussed the issues involved in deciding what disaster data should be collected. Prior to a disaster event, efforts need to be focused on collecting data about the most at risk populations and areas. Population, land use, and infrastructure data were especially identified as being critical to collect prior to an event so the data can be available during the response to an event. The workshop participants indicated that more specific information about infrastructure such as building elevation need to be collected. When data is being collected during the response to an event, the data collection teams should attempt to prioritize collecting rich, time-sensitive data that is often lost because of its fleeting nature.

Workshop participants repeatedly emphasized that standardized and common data collection forms are critical to comprehensive data collection. Common data collection forms also facilitate comparisons from one disaster event to another. Existing data collection forms used by groups such as EERI could be used to generate common data forms for NC. The workshop participants also indicated that having the forms electronically partially completed prior to team deployment with known information (such as building address) would reduce data collection time. Data collection efforts also would have to account for personal privacy, government security, and cultural sensitivity issues.

Data Format Issues

The key issues identified in the workshop with respect to data format were as follows.

- Data needs to be stored in a format that facilitates sharing and analysis,
- First responders need data formatted appropriately for their use, and
- Common data format standards need to be developed and regularly used.

The workshop participants looked at how to format collected disaster data so it can be of greatest use to the emergency management community. Prior to a disaster event, data needs to be stored in a format that will facilitate sharing and interpretation of the data. For example, workshop participants mentioned assigning a building one of four categories based on how critical it is to its community. Another idea was to have critical facilities prepare a "lock box" at the entry of a facility with information and items inside that would be important to first responders. A "lock box" for an assisted living home could include the number and room location of disabled individuals, elevator keys, a building plan, and the dimensions of egress from streets. One workshop group expressed that most infrastructure data that is known prior to a disaster event is appropriate for input into a GIS.

First responders need ready access to disaster data that exists in external files and databases. The workshop participants discussed the ideal way to format disaster data so first responders could easily gain access to it in their vehicles. First, the data would need to be prepared and possibly re-formatted for delivery to first responders in the field. In the case of digital data, data sets, such as GIS layers, would need to be prepared for display on in-vehicle consoles. Paper documents would need to be uniformly produced and distributed to first responder stations. Workshop participants noted that digital format data might not be ideal for rural localities with limited information technology budgets. Also, the resolution of data may need to change as presented to different users, so different resolution levels of data need to be created and archived.

Workshop participants repeatedly emphasized the importance of collecting and storing disaster data in a common format. A common format would include a common set of units of measure, metadata standards, and storage in a file format that can be easily viewed by users. A common set of units of measure can be agreed upon by data collection teams and the emergency management community and reinforced through common data entry forms. Common data entry forms also would encourage creating metadata for each data set, including photo galleries. The metadata should be easily verifiable and accessible. Workshop participants also indicated that data set files should be in an interchangeable format that would allow the data to be easily imported into commonly available programs, such as Microsoft Word. Participants suggested that an information technology subcommittee for the state could be formed from FEMA, state, county, local experts, and researchers to determine format standards.

Data Dissemination Issues

The key issues identified in the workshop with respect to data dissemination were as follows.

- Providing real-time data dissemination to first responders,
- Utilizing the media to disseminate information to the public, and
- Implementing common data management at all government levels.

During the third workshop session on Thursday, the workshop participants looked at how data is disseminated for the particular disaster assigned to the small group. On Friday during the first session in the morning, the small groups looked at disaster data dissemination issues in general. Several groups felt that access to needed disaster data during an event often does not happen. In other words, there is a lot of information that exists and is of value that is not disseminated to first responders and to response planners. These groups need real-time dissemination of information, especially data about specific geographical areas and available emergency management resources. Data can be delivered to first responders, who can either be professionals or volunteers, at the point of service or at the point of decision depending on the situation. Workshop participants identified the media as being effective for disseminating some disaster information to the public.

In order to disseminate all available data quickly, national, state, and local data resources need to be linked to each other and to local users. Workshop participants expressed the view that local communities need to take on the data management initiative because the state and federal government will not keep the sufficiently detailed local data that is needed. Participants also felt that getting state and federal agencies to buy into common data management would be challenging, but necessary.

Data Maintenance Issues

The key issues identified in the workshop with respect to data maintenance were as follows.

- The need for formal agreements on data maintenance procedures,
- Commonly needed data sets should be prioritized for frequent maintenance, and
- Data should be well documented and archived using metadata.

Workshop participants articulated that there needs to be a formal agreement in place on how data is maintained both within an organization and among the organizations involved in common data management. Within an organization, employee turnover was mentioned as a factor that would hinder data maintenance. Data maintenance includes updating, documenting, and archiving data. Participants suggested that data maintenance efforts should be prioritized in order of the most commonly needed data sets. Older, and possibly now inaccurate data, such as older flood maps, needs to be identified and updated regularly.

Disaster data needs to be well documented (using metadata) and archived so that it can easily be used in disaster mitigation, preparation, and response analysis and efforts. Workshop participants expressed that well documented and archived data will facilitate post-event analyses that can be used to encourage new research and new emergency management methods. Ongoing training in how to properly update, document, and archive data according to future agreed upon standards is also needed according to the workshop participants.

DATA COLLECTION TEAMS

During the final session of the workshop on Friday, the participants listened to a presentation by Dr. Ken Taylor, Director of the North Carolina Emergency Management Division (NCEM). Dr. Taylor spoke about the need for better coordination of data collection efforts during disasters and possible ways to organize data collection teams (DCT). The DCT for NC would be composed of professionals and academics in areas related to disaster research. After the presentation, the workshop participants discussed how to implement these teams in NC.

Dr. Taylor began his presentation with an anecdote of how uncoordinated data collection efforts have been during past disasters. During Hurricane Isabel in 2003, seven separate agencies recorded the extent of a coastal breach in the Outer Banks. The Department of Homeland Security took infrared video of the breach, the Army Corps of Engineers took digital aerial photos, the NCDOT took analog aerial photos and scanned them into a database, the USGS and the National Oceanic and Atmospheric Administration (NOAA) took LIDAR data, and the Civil Air Patrol and North Carolina National Guard took digital oblique photography of the breach. Although the breach was recorded using many methods, there was still some information, such as photograph location and time, which was hard to determine due to the lack of metadata about the imagery. The inability to link photographs and video imagery to a specific point in space and time limits their future utility to the emergency management community and disaster researchers.

Team Objectives

There are four objectives that the DCT seeks to achieve as noted below.

1. Data Preservation,
2. Data Collection and Archiving,
3. Data Reporting and Analysis, and
4. Placing Data Layers in a Common Repository.

Achieving the first two objectives would ensure that critical data is not only collected, but it is properly archived and maintained. The third objective, data reporting and analysis, would occur after a disaster event once all data is collected and archived and would require the dissemination of results to the emergency management and academic community. The final objective, placing data layers in a common repository, would ensure that the data collected can be disseminated easily to others for their own analysis in the future.

These four objectives can be related to the data management issues discussed in the previous chapter. Data maintenance involves the first objective, data preservation and also part of the second objective, archiving. The second objective also includes data collection, which is one of the disaster data management issues. Data reporting and analysis is part of data dissemination, and the fourth objective of placing data layers in a common repository is related to data format because a repository requires data standards. The data dissemination issue also involves gathering data layers to place in a common data management structure.

Team Requirements

For the DCT to be successful in their efforts and not hamper the formal emergency response efforts, the teams have to meet four requirements.

1. Rapid Onset,
2. Sustained Involvement,
3. Training, and
4. Self-Controlled in Incident Command System.

In order to meet these requirements, the data collection teams will need to have an operating structure in place prior to a disaster. Without a pre-existing arrangement, the requirement of rapid onset will not be met because the teams will lose valuable data collecting time while mobilizing. Sustained involvement includes meeting the team objectives repeatedly during every disaster and consistent involvement in all major disasters in the state. Regular training of DCT members prior to an event ensures that each team member can quickly and properly perform their assigned team duties. Team duties beyond data collection would include organizing operations, planning team response, team logistics, and team finances.

The DCT need to be self-controlled in the NCEM incident command system so that they already have their credentials ready and understand their role and priority in the disaster response. In other words, the teams will need to clearly understand how to not get in the way of the rest of the emergency response and not be a burden to the emergency managers.

Team Limiting Factors

The success of the DCT will be limited by several factors.

1. Level of Safety Training,
2. Availability of DCT Members, and
3. Logistics.

Safety training is necessary for the DCT because of the hazards associated with working in an area affected by a disaster. The emergency responders do not want to deal with the added complication of injured DCT members, because it distracts from their main objective. The main responsibility of emergency responders during a disaster is to care for those hurt or threatened by the disaster.

Availability of members is another critical limiting factor since the DCT members will be drawn from across NC, making transportation an issue. Also, any DCT members that are teaching will need to arrange for substitutes while they are participating in the DCT, and DCT members with family responsibilities may not be available during family emergencies.

Logistics is the largest limiting factor to the DCT. The University of North Carolina (UNC) system may need to play a large role in logistics for the teams. Universities close to the affected areas could provide housing, food, and resources for the teams at a reduced cost.

Team Types

The DCT were envisioned to take the lead in producing impact assessments for disasters that they are deployed for. The impact assessment would outline how the disaster truly impacted the economy, society, resources, and infrastructure. Three types of DCT are needed to perform a thorough data collection.

- Type R – broad reconnaissance,
- Type G – hazard specific areas, and
- Type D – individual discipline.

The Type R team would arrive within one day of the event and quickly assess the need for immediate data collection. Once this assessment is made, the Type G groups are determined based on the disaster type. For example, a flood may require immediate deployment of water experts, while a building collapse might require structural engineering expertise. The Type G groups would be deployed for about a week and have a narrower scope than the Type R teams.

The type D teams would be assembled within one week of the disaster and would collect data for the areas that the DCT organization has decided should be collected for every event. Each type D team would be composed of experts in a particular area, such as vulnerable populations, and have fewer than 10 members under the control of a trained principal investigator. They would record their data on common forms created prior to the event to ensure uniform data collection between teams.

During the discussion of the DCT proposal, workshop participants though that DCT members, especially the principal investigators, should have interdisciplinary skills, so that they could deal with different assignment situations. Participants also felt that DCT members should be sensitive to interdisciplinary needs and try not to have "tunnel vision," and that the university system may not be able to handle the logistics of the DCT without a committed agreement.

The DCT that are advocated here in this section are the same as those mentioned in the *Coordination of Data Collection Efforts* section near the beginning of this report. There are also other ways to collect disaster data. For example, the use of instrumentation, and not humans, to collect data is discussed in the *Instrumentation* section.

WORKSHOP RESULTS

Looking at the various findings from the workshop sessions, some common themes emerge. The discussions on data needs, resources, and data dissemination were used to create and implement a multi-disaster data model developed by the workshop planning committee. The discussions on data needs and resources also led to identifying the data items that participants in each of the four disaster groups identified as important to their assigned disaster. These needed data items form a common data set for the four disasters investigated by the workshop, as well as possibly for other disasters not investigated. The common data set developed from the workshop discussions is combined with the common data items included in the HAZUS-MH inventory data set to create a common multi-disaster data model. Also generated from the workshop discussions are a set of disaster data collection and management objectives for NC.

Multi-Disaster Data Model

After the completion of the three sessions on the first day (Thursday) of the workshop, the workshop planning committee met to discuss how the findings from the first day would change how the workshop sessions on the second day (Friday) would be conducted. The greatest focus was on the first session of the second day, which would focus on common data sets needed across multiple disaster types.

The original multi-disaster data model used to elicit participants' responses during the first three sessions of the workshop had four general data areas (Appendix G). The four areas in the original multi-disaster model, shown in Table 9, were inventory data (compiled prior to an event), infrastructure damage data, population and human infrastructure, and emergency response resources. These areas focused not only on the type of data but when it was compiled (either before, during, or after a disaster event). The latter three data areas are all compiled during and after the disaster event.

Table 9. Original Multi-Disaster Data Model

Disaster Data Areas	Compilation Period
Inventory Data	Prior to an Event
Infrastructure Damage Data	During and After Event
Population and Human Infrastructure	During and After Event
Emergency Response Resources	During and After Event

<u>Development of New Four Areas Model</u>

The new multi-disaster data model developed by the workshop planning committee for Friday's sessions also has four data areas, but the four new areas have no compilation period requirement. The new model, also known as the four areas model, consisted of four disaster data areas: hazard, infrastructure, population, and response resources. Each of the four areas covers a different partition of disaster data. The new model, besides removing the compilation period references, also added a new area, hazard, which was not included in the original model, but was found during Thursday's workshop sessions to be an area where a lot of disaster data was needed and collected. The new four areas model is represented in Figure 7.

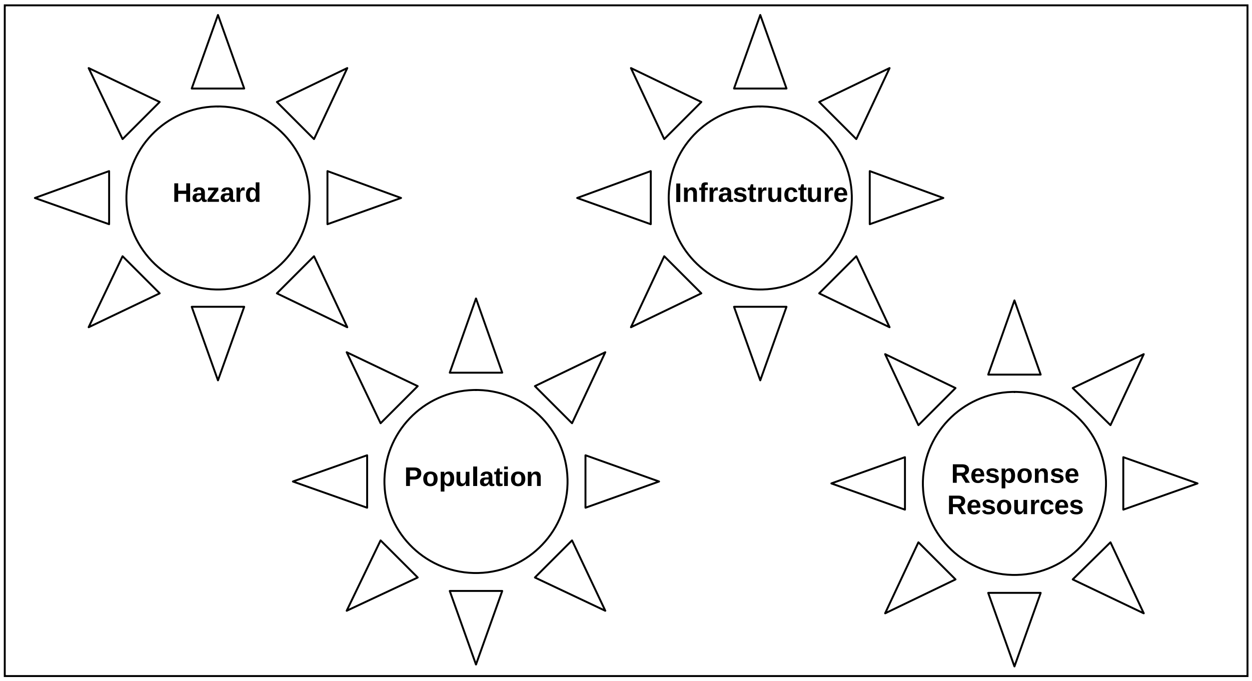

Figure 7. New Four Areas Multi-Disaster Data Model

The four areas disaster model shown in Figure 7 was originally conceived of as a wheel with several spokes. Each spoke represents a data set belonging to the adjacent data area (wheel/circle). One data set is differentiated from another data set if the data sets are collected at different times or have a different level of detail. The orientation of a spoke on the wheel is unique to the data set. For example, for any disaster, the evacuation plan data set would appear at the 12 o'clock position on the response resources wheel. A set of wheels and spokes can be developed for each disaster type, such as an explosion or flood. Because each disaster type has different combinations of needed data sets, their models will have areas (wheels) with different numbers of spokes. The wheel and spoke design of the data model enables easy recognition of the number and type of data sets belonging to each area.

As the data sets needed for each data area in the model were gathered from the workshop session findings, it became apparent that visually representing the four areas data model using the spoke and wheel scheme would be difficult. One drawback to the spoke and wheel design is that each disaster type's four areas model would require an entire page to display. This would make it harder to easily compare the common data sets between disaster types. Another drawback to the spoke and wheel design is that it is time consuming to illustrate. Because of these difficulties, the four areas model was visually reconceived as a single page matrix showing all four data areas and all disaster types considered at the workshop.

Model Implementation

The revised four areas model can be applied to interpret the workshop data needs findings from the four disaster types examined. The model facilitates comparisons between the data needs for each of the four disasters, which then identifies the common data needs among the four disasters. Each of the four disaster types (wind, ice, flood, and explosion) studied in the workshop have

Table 10. Four Areas Model from Workshop Comments and Assessment

Data Areas and Associated Data Set		Wind	Ice	Flood	Explosion
		DISASTER TYPE			
HAZARD	Historical weather and damage data	X	X	O	
	Current weather data and conditions	X	X	O	
	Hazard impact area extents	O	X	O	O
	Flood water level and location			X	
	Type of explosive and size				X
	Locations and characteristics of target				X
INFRASTRUCTURE	Location and attributes of buildings and property	X	O	X	X
	Transportation network location and attributes	X	O	X	X
	Critical business locations	X	O	O	O
	Hospital locations	X	O	O	O
	Senior center locations	X	O	O	O
	School locations	X	O	O	O
	Agricultural operations location	X		O	
	Level of damage to structures	X		O	X
	Status of transportation network	X	X	X	X
	Final structural damage survey	X		O	O
	Interruption to business and agriculture	X	O	X	O
	Changes to built landscape	X		O	O
	Status of power service	O	X	X	X
	Location and availability of backup power	O	X	X	X
	Historical power outage data	O	X	O	
	Snow removal plans		X		
	Airport Status and Closures	O	X	O	
	Location and attributes of water/sewer system			X	X
	Status of water/sewer system			X	X
	Attributes and Location of Power Service	O	O	O	X
	Attributes and location of telecommunications	O	O	O	X
	Status of telecommunications	O	O	O	X
POPULATION	Demographics	X	X	X	O
	Density	X	O	O	O
	Location and attributes of special needs population	X	X	X	O
	Seasonal, school, and prison population	X	O	X	
	Size of exposed population	X	O	X	O
	Size of evacuated population	X		O	X
	Shelter population	X	X	O	
	Cultural population and their cultural needs	O	X	X	O
	Number, type, and location of injuries and deaths	O	X	X	X
	Animals impacted	O	O	X	O
RESPONSE RESOURCES	Evacuation plan	X		O	X
	Evacuation route status	X		O	O
	Location and abilities of special teams	O	X	X	X
	Location of shelters and capacity	O	X	O	X
	Transportation available to shelter	O	X	O	O
	Food/goods available for response, shelters	O	X	O	X
	Volunteer availability	O	X	O	X
	Pre-event plans	O	O	O	X
	Availability of health facilities, number of beds	O	O	O	X

X: Data set – disaster type relationship from workshop comments
O: Data set – disaster type relationship from author's assessment

their data needs modeled using the four areas model as shown in Table 10. Appendix M contains definitions for some of the broader terms (such as transportation network) used in the model illustrations.

In Table 10 two different symbols (*X* and *O*) are used to show that a data set is needed by a disaster type. The *X* indicates a relationship between a data set and a disaster type generated from workshop participant comments, while an *O* indicates a relationship between a data set and a disaster type that the authors consider to exist, but that the workshop participants did not address in their discussions.

For example, the wind group only listed an evacuation plan and evacuation route status as data sets for the response resources area, while the ice group also listed the location and abilities of special teams, the location and capacity of shelters, volunteer availability, and the foods and goods available for use in the response. The response resources data sets listed by the ice group would also be needed in a wind event response, but the wind group did not identify them in their discussions.

Data sets that are needed by all four disaster types are shaded gray in Table 10. A four areas model with only the relationships between data sets and disaster types generated from the workshop participant comments is given in Appendix N.

Workshop Common Disaster Data Set

The four areas models developed for the four disaster types discussed in the workshop can be used to find common data sets needed for all disasters. The data sets that are shaded gray in Table 10 are commonly needed by all four disaster types. Some data sets that are not shaded gray, such as historical and current weather information, apply to the three meteorological disaster types (wind, ice, flood) but not to the explosion disaster type because weather effects are not involved in the explosion disaster type. If the historical and current weather information data sets have their name changed to the more general terms historical hazard information and current hazard information, then these two data sets would be commonly needed by all four disaster types investigated in the workshop.

Table 11, which lists the common data set items derived from the four disasters discussed in the workshop, was developed using the shaded data sets from Table 10 as well as the historical and current hazard information data sets that were generalized using the rationale in the preceding paragraph.

Common Multi-Disaster Data Model

The common data sets developed in Table 11 were from the workshop discussions alone, and did not consider data sets needed or used by the Disaster Management Systems that were discussed at the beginning of this report. By considering both the needed data sets from the workshop as well as from the DMSs, a common multi-disaster data model can be developed that summarizes all of the data needs investigated herein.

Table 11. Common Data Sets from Workshop

Area	Common Data Sets
HAZARD	Hazard impact area extents, Historical hazard information, Current hazard information
INFRASTRUCTURE	Location and attributes of buildings and property, Transportation network location and attributes, Critical business locations, Hospital locations, Senior center locations, School locations, Status of transportation network, Interruption to business and agriculture, Status of power service, Location and availability of backup power, Attributes and Location of Power Service Attributes and location of telecommunications, Status of telecommunications
POPULATION	Demographics, Density, Location and attributes of special needs population, Size of exposed population, Cultural population and their cultural needs, Number, type, and location of injuries and deaths, Animals impacted
RESPONSE RESOURCES	Location and abilities of special teams, Location of shelters and capacity, Transportation available to shelter, Food/goods available for response, shelters, Volunteer availability, Pre-event plans, Availability of health facilities, number of beds

In order to develop this common multi-disaster data model, the data sets needed by the DMSs had to be determined. Of the DMSs discussed in this report, HAZUS-MH had the most comprehensive data needs information, which is contained in Appendix A. The data needs for the other DMSs were more general and were included in the exhaustive HAZUS-MH required data sets. The only data need that was included in the other DMSs and not in HAZUS-MH was the need for an incident management system to be developed and made operational.

The data sets needed by the DMSs have been assembled in Appendix O. HAZUS-MH data sets were included in Appendix O if they were needed in two out of the three disasters modeled by HAZUS-MH (earthquake, flood, and hurricane) as shown in Table Set 1 of Appendix A. The data set *location and availability of backup power* does not appear in Table Set 1 of Appendix A as a HAZUS-MH data set, but through inspection of Table Set 2 in Appendix A, most infrastructure data sets included the availability of backup power in their data fields.

After Appendix O was developed, it was combined with Table 11 to create a common multi-disaster data model. This model is shown in Table 12. The source of each data set, either from the workshop findings in Table 11, the DMS literature search summarized in Appendix O, or from data sets in Table 9, is given in the *Source* column of Table 12. The data sets added to Table 12 by the authors may not be applicable in all disaster types, but are necessary data sets for several disaster types. For example, the *level of damage to structures* data set (*INFRASTRUCTURE*) is not a key data set in an ice storm, since this disaster does not typically damage structures, but in the case of an earthquake or hurricane, the level of damage to structures is much needed information.

The *Inventory* and *Status* columns in Table 12 indicate whether a data set can be populated prior to a disaster event or populated in real-time during and after a disaster event, respectively. Most of the data sets from the DMS literature review (mostly HAZUS-MH data sets) were inventory data sets because HAZUS-MH is primarily used for planning and determining probable extents of disaster damage; it is not used to determine actual damage or response status. Definitions for data sets used in Table 11 can be found in Appendix M.

Organizations that might use the common data set in Table 12 need to examine available data resources to determine what data sets have already been developed in their region and which need to be created. For status data sets, much of the data will come from real-time databases updated by specific organizations or from data collection teams in the field.

Team Data Collection

Data collection teams deployed in a disaster-affected area can contribute significantly to the amount and quality of data available during and after a disaster. The workshop discussed an agenda for creating these teams in NC, but many of the recommendations from the workshop can be used in any region to implement disaster data collection teams.

Data collection teams comprised of regional experts, professionals, and academics who work in areas related to disasters are a part of an overall disaster data management strategy. The teams coordinate and limit duplication of data collection efforts. The teams work to preserve, collect, archive, report, and analyze disaster data. The common data set in Table 10 can serve as a basic guide for what information data collection teams should collect. Additional data items should be added to the data collection teams' agenda based on the specific characteristics of the disaster and region.

To collect disaster data, the teams will need standard instruments, cameras, video recorders, procedures and forms. Common data forms will ensure that the individual teams all collect data in the same format. The teams also have to be self-reliant, having their training, procedures, assigned geographical area, logistics, and credentials arranged prior to any disaster event. Management of data collection teams is a low priority for emergency management professionals in times of disaster. More research needs to be done on how best to train, equip, and coordinate effective data collection teams.

Table 12. Common Multi-Disaster Data Model

Data Areas and Associated Data Set		Source	Inventory	Status
HAZARD	Historical hazard information	n	X	
	Current hazard information	n		X
	Hazard impact area extents	n		X
INFRASTRUCTURE	Location and attributes of buildings and property	n ¤	X	
	Level of damage to structures	u		X
	Transportation network location and attributes	n ¤	X	
	Status of transportation network	n		X
	Critical business locations	n	X	
	Interruption to business and agriculture	n		X
	Medical care locations and regular capacity	n ¤	X	
	Senior center locations	n	X	
	School locations	n ¤	X	
	High potential loss facilities locations	¤	X	
	Attributes and location of power service	n ¤	X	
	Status of power service	n		X
	Location and availability of backup power	n ¤	X	
	Oil/natural gas pipelines location and attributes	¤	X	
	Location and attributes of water/sewer system	¤	X	
	Status of water/sewer system	u		X
	Attributes and location of telecommunications	n ¤	X	
	Status of telecommunications	n		X
POPULATION	Demographics	n ¤	X	
	Density	n	X	
	Location and attributes of special needs population	n	X	
	Seasonal, school, and prison population	u	X	
	Size of exposed population	n		X
	Size of evacuated population	u		X
	Shelter population	u		X
	Cultural population and their cultural needs	n	X	
	Number, type, and location of injuries and deaths	n		X
	Animals impacted	n		X
RESPONSE RESOURCES	Location and abilities of special teams	n	X	
	Fire and police station locations and attributes	¤	X	
	Location of shelters and capacity	n ¤	X	
	Transportation available to shelter	n	X	X
	Food/goods available for response, shelters	n	X	X
	Volunteer availability	n	X	X
	Evacuation plans	u	X	
	Pre-event plans / IMS procedures	n ¤	X	
	Availability of health facilities, number of beds	n		X

n: *Common set from workshop findings* ¤: *Data set from DMS literature review*
u: *Data set from workshop, added by authors*

Disaster Data Management

From workshop participants' discussions on disaster data management and data collection teams, several disaster data management objectives emerge. These include the following.

1. Creating standards for data collection, format, dissemination, and maintenance,
2. Training data collectors and users in standards and best practices,
3. Prioritizing management of critical and most commonly needed data,
4. Recognizing the audience for a data item and changing the dissemination method and format accordingly,
5. Promoting local, state, and national partnerships to facilitate data sharing and interoperability, and
6. Communicating to avoid duplication of data collection efforts.

The first two objectives ensure that there are data management standards and that data collectors and users know how to implement them properly. The third objective, prioritizing the management of the critical and most commonly needed data, provides an agenda for implementing data management that maximizes the value of the time spent on data management. Recognizing the audience for a data item and changing the dissemination method and format accordingly also adds value to data management efforts because first responders and other emergency management professionals can easily use the data that is disseminated. The fifth objective emphasizes how vital local, state, and federal cooperation is to a successful disaster data management effort. Local, state, and federal agencies also need to regularly communicate so that they can better coordinate data collection efforts and reduce redundancies.

CONCLUSIONS

From this study several conclusions can be drawn about disaster data and its management. These emerge from the NCSU Disaster Data Workshop results and previous workshops and disaster management systems efforts. These were outlined in the previous chapter.

Existing data collection and management efforts focus primarily on inventory data, since this information is available regardless of a disaster event. The list of data items included in the HAZUS-MH program, given in Appendix A, as well as the inventory items in Table 12 can serve as a fundamental set of inventory data. The HAZUS-MH data sets are very comprehensive in the areas of infrastructure and less detailed in the areas of hazard, population, and response resources. Since status data can often only be captured during or just after a disaster event, it is much more difficult to collect, archive, and report. Table 12 also generally lists status data items that need to be collected. For a specific disaster type a more specific status data item list can be developed knowing what hazard information (such as flood height) is most needed for response activities and for future research.

Several disaster-related groups have tackled the issues of disaster data management and collection. EERI has developed a mature global data collection and management system for earthquakes. It is an excellent model of how to organize and mobilize data collection teams, using standard data collection forms and procedures. NCIDS is notable for its workshops that evaluate how to better plan for and respond to disasters in NC. From their workshops, they have found a need to better coordinate the academic community in disaster research, create a disaster data repository, and emphasize including population and health issues in disaster planning and data collection. NCEM’s frustration with uncoordinated data collection efforts led to their proposal to create data collection teams in NC.

The NCSU Disaster Data Workshop sought to build on previous efforts to develop a common data set and to improve disaster data management. The small workshop breakout groups were able to generate many needed data items and data management ideas. Each group, with its own disaster type, tended to focus on one data area, such as hazard or population information. The areas of expertise of the participants and their facilitator(s) usually determined the focus of the group. More time to consider more disaster types, or just the disaster types already included in the workshop, could have resulted in a different common data set result.

The four areas model developed from the workshop allows all of the data items the workshop participants could think of to be assigned to a data area. Other definitions of data areas could also be used in developing a common data set. The need to generalize hazard information in order to create commonality across the four disaster types caused specific hazard information needs (such as flood water level and explosive type) to be left out of the common data set model. The common data set model developed from the workshop is also biased toward the data needs of NC. In California, to consider an alternative example, they are not too worried about ice storms and hurricanes but about earthquakes and wildfires. This shift in emphasis would impact the data sets that would be commonly needed to manage the most frequently occurring disasters in a region.

The workshop discussions on data collection teams and data management were a good first step towards the creation of data collection teams and more coordinated disaster data management in NC. Most of the workshop findings in these two areas are applicable to other regions also. From the results of the workshop discussions on data collection teams and disaster data management, the following disaster data collection and management cycle was developed.

1. Standards – collection, format, maintenance, dissemination
2. Form and train teams
3. Make partnerships and agreements
4. Collect Data
5. Maintain Data
6. Disseminate Data
7. Evaluate Post-Event
8. Return to Step 1

This cycle can serve as an agenda for both the development and operations of disaster data collection teams as well as a common disaster data repository. Once the needed data has been collected and organized, it can be used to improve NC's, or any region's, performance in all six phases of the disaster cycle.

RECOMMENDATIONS

Both the NCSU Disaster Data Workshop discussions and the research into other disaster data management efforts, led to the development of recommendations for both disaster data management in NC as well as for any region in general.

The main recommendations from this study are as follows.

- Organize another workshop on the topic of data collection teams in NC,
- Begin developing a common disaster data repository in NC,
- Prioritize data collection efforts based on the criticality of the data set,
- Train and well prepare disaster data collection teams for their duties,
- Further investigate the data needs of disaster types not addressed in this workshop, and
- Work to better utilize instrumentation to collect short-lived, but important data.

North Carolina Recommendations

Two specific recommendations for NC emerged from this study.

- Organize another workshop on the topic of data collection teams and
- Begin developing a common disaster data repository.

Workshop participants involved in the ice disaster group felt that there was little research into the impacts and characteristics of ice storms in NC. They recommended more research in the area of ice storms, especially in the areas of power outages, highway congestion, fallen trees, and ice on roadways.

It was determined that there should be another workshop or meeting held in NC specifically to discuss the further development of data collection teams and coordination of data management in the state. The workshop should include all stakeholders who would be involved in staffing the teams and helping with logistics.

The development of a common disaster data repository in NC would aid and encourage further research efforts into disaster preparedness and response. This repository also would facilitate inter-agency data sharing between state emergency management and local first responders and governments.

General Recommendations

There are four specific recommendations for disaster data management in general.

- Prioritize data collection efforts based on the criticality of the data set,
- Train and well prepare disaster data collection teams for their duties,
- Further investigate the data needs of disaster types not addressed in this workshop, and
- Work to better utilize instrumentation to collect short-lived, but important data.

Using the common data set as a starting point, data resources need to be gathered to populate the data sets with information. The data sets that currently have very little or no available information should be prioritized for development based on how critical they are to the region's disaster preparedness and response. Criticality is the foremost criteria for data population sequencing.

Disaster data collection teams should be self-reliant so that they do not unnecessarily burden emergency management professionals during a disaster event. Team members should be first trained in standard data collection and safety procedures. The teams must also have available the needed equipment and data forms. Once an event occurs and the teams are mobilized, credentials, transportation, and shelter will need to be quickly arranged, if not arranged beforehand. The leader of the data collection teams must ensure that teams are assigned according to data collection priorities, that essential time-sensitive data is collected, and that duplication of efforts is kept to a minimum.

Disaster types that were not addressed in the NCSU Disaster Data Workshop should also be investigated to better understand their data needs and resources. These new data needs can be incorporated into the common data set.

Instrumentation should be installed in locations (such as bridges, dams, and levees) where essential and short-lived disaster data can be captured and quickly communicated to emergency managers. Cooperation between emergency management organizations and managers of infrastructure systems (such as transportation and utilities) also needs to improve so that real-time data can be readily available to first responders and emergency managers.

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APPENDICES

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Appendix A HAZUS-MH Default Inventory Information

This appendix lists the inventory data sets that are shipped with HAZUS-MH. It is broken into two parts as follows.

- Table Set 1: Inventory Data Sources
- Table Set 2: Inventory Data Fields

Table Set 1 lists each inventory data set the HAZUS-MH model is used for, and lists its national and local data sources. These two tables can be found in Appendix E of FEMA Publication 433 (FEMA, 2004).

Table Set 1: Inventory Data Sources

Inventory Asset Category	Used for HAZUS-MH Model			HAZUS-MH Provided Data Source (Year)	Examples of Potential Local Sources for Data
	EQ	Flood	Hurr		
General Building Stock					
	X	X	X	U.S. Census Bureau and Dun & Bradstreet (2000)	Tax assessors offices, zoning departments, regional and local planning commissions
Essential Facilities					
Medical Care	X	X	X	American Hospital Association (2000)	Electronic Yellow Pages, State EMA, LEPC
Emergency Response	X	X	X	InfoUSA, Inc. (2001)	State EMA, LEPC
Schools	X	X	X	National Center for Education Statistics, Department of Education (2003)	Board of Education, Electronic Yellow Pages
Fire Stations	X	X	X	InfoUSA, Inc. (2001)	State EMA, LEPC, Fire Chief
Police Stations	X	X	X	InfoUSA, Inc. (2001)	State EMA, LEPC, Police Commissioner
HazMat Facilities					
	X	X	X	Toxic Release Inventory Database, EPA (1999)	State EMA, LEPC, Fire Department, State and local environmental organizations
High Potential Loss Facilities					
Dams	X	X	X	National Inventory of Dams, USACE (2003)	Local or regional authorities, State EMA, state and local planning department
Levees	X	X	X	N/A	Local flood mitigation organizations, ASFPM
Nuclear Power Facilities	X	X	X	U.S. Nuclear Regulatory Commission (2003)	Not applicable
Military Installations	X	X	X	N/A	State Reserve Units (to supplement Federal data)
Transportation Systems					
Highway Segments	X	X	X	Tiger/Line Files, U.S. Census Bureau (2000)	State or local DOT, regional or local planning commissions
Highway Bridges	X	X	X	National Bridge Inventory Database, FHWA (2001)	State or local DOT, regional or local planning commissions
Highway Tunnels	X	X	X	National Bridge Inventory Database, FHWA (2001)	State or local DOT, regional or local planning commissions
Rail Segments	X	X	X	National Rail Network Database, Bureau of Transportation Statistics (2000)	State or local DOT, regional or local planning commissions
Rail Bridges	X	X	X	National Bridge Inventory Database, FHWA (2001)	State or local DOT, regional or local planning commissions
Rail Tunnels	X	X	X	National Bridge Inventory Database, FHWA (2001)	State or local DOT, regional or local planning commissions
Rail Facilities	X	X	X	N/A	State or local DOT, regional or local planning commissions
Light Rail Segments	X	X	X	Fixed-Guideway Transit and Ferry Network Database, BOTS, U.S. DOT (2000)	State or local DOT, regional or local planning commissions
Light Rail Bridges	X	X	X	National Bridge Inventory Database, FHWA (2001)	State or local DOT, regional or local planning commissions
Light Rail Tunnels	X	X	X	National Bridge Inventory Database, FHWA (2001)	State or local DOT, regional or local planning commissions
Light Rail Facilities	X	X	X	N/A	State or local DOT, regional or local planning commissions
Bus	X	X	X	InfoUSA, Inc. (2000)	State or local DOT, regional or local planning commissions, Electronic Yellow Pages
Port	X	X	X	Port and Waterway Facilities Database, USACE (2000)	State or local DOT, regional or local planning commissions

Inventory Asset Category	Used for HAZUS-MH Model			HAZUS-MH Provided Data Source (Year)	Examples of Potential Local Sources for Data
	EQ	Flood	Hurr		
Ferry	X	X	X	Port and Waterway Facilities Database, USACE (2000)	State or local DOT, regional or local planning commissions, Electronic Yellow Pages
Airport Facilities	X	X	X	BDTS, U.S. DOT (1999)	State or local DOT, regional or local planning commissions, Electronic Yellow Pages
Airport Runways	X	X	X	BDTS, U.S. DOT (1999)	State or local DOT, regional or local planning commissions
Utility Systems					
Potable Water Pipelines	X	X	X	EPA Envirofacts Data Warehouse LRT Tool (2001)	State or local water departments, private utilities, regional or local planning commissions
Potable Water Distribution Pipes (by Census tract)	X			EPA Envirofacts Data Warehouse LRT Tool (2001)	State or local water departments, private utilities, regional or local planning commissions
Potable Water Network System Pumps		X		EPA Envirofacts Data Warehouse LRT Tool (2001)	State or local water departments, private utilities, regional or local planning commissions
Potable Water Control Vaults and Control Stations		X		EPA Envirofacts Data Warehouse LRT Tool (2001)	State or local water departments, private utilities, regional or local planning commissions
Potable Water Network System Tanks		X		EPA Envirofacts Data Warehouse LRT Tool (2001)	State or local water departments, private utilities, regional or local planning commissions
Potable Water Network System Wells		X		EPA Envirofacts Data Warehouse LRT Tool (2001)	State or local water departments, private utilities, regional or local planning commissions, well logs (local environmental agency water division)
Potable Water System Facilities	X	X	X	EPA Envirofacts Data Warehouse LRT Tool (2001)	State or local water departments, private utilities, regional or local planning commissions
Wastewater Pipelines	X	X	X	EPA Envirofacts Data Warehouse LRT Tool (2001)	State or local water departments, private utilities, regional or local planning commissions
Crude and Refined Oil Piplines	X	X	X	EPA Envirofacts Data Warehouse LRT Tool (2001)	State and local fire departments, environmental agencies, State EMA and LEPC, private companies
Oil Refineries		X		EPA Envirofacts Data Warehouse LRT Tool (2001)	State and local fire departments, environmental agencies, State EMA and LEPC, private companies
Oil Pumping Plants		X		EPA Envirofacts Data Warehouse LRT Tool (2001)	State and local fire departments, environmental agencies, State EMA and LEPC, private companies
Oil Tank Farm		X		EPA Envirofacts Data Warehouse LRT Tool (2001)	State and local fire departments, environmental agencies, State EMA and LEPC, private companies
Oil Control Vaults and Control Stations		X		EPA Envirofacts Data Warehouse LRT Tool (2001)	State and local fire departments, environmental agencies, State EMA and LEPC, private companies
Crude and Refined Oil Pipeline Facilities	X		X	EPA Envirofacts Data Warehouse LRT Tool (2001)	State and local fire departments, environmental agencies, State EMA and LEPC, private companies
Natural Gas Pipelines	X	X	X	EPA Envirofacts Data Warehouse LRT Tool (2001)	State and local fire departments, environmental agencies, State EMA and LEPC, private companies
Natural Gas Distribution Pipes (by Census tract)	X			EPA Envirofacts Data Warehouse LRT Tool (2001)	State and local fire departments, environmental agencies, State EMA and LEPC, private companies
Natural Gas Compressor Plants		X		EPA Envirofacts Data Warehouse LRT Tool (2001)	State and local fire departments, environmental agencies, State EMA and LEPC, private companies
Natural Gas Control Vaults and Control Stations		X		EPA Envirofacts Data Warehouse LRT Tool (2001)	State and local fire departments, environmental agencies, State EMA and LEPC, private companies
Natural Gas Facilities	X		X	EPA Envirofacts Data Warehouse LRT Tool (2001)	State and local fire departments, environmental agencies, State EMA and LEPC, private companies
Electric Power Plants		X		EPA Envirofacts Data Warehouse LRT Tool (2001)	State and local fire departments, environmental agencies, State EMA and LEPC, private companies
Electric Power Substations		X		EPA Envirofacts Data Warehouse LRT Tool (2001)	State and local fire departments, environmental agencies, State EMA and LEPC, private companies

Inventory Asset Category	Used for HAZUS-MH Model			HAZUS-MH Provided Data Source (Year)	Examples of Potential Local Sources for Data
	EQ	Flood	Hurr		
Wastewater Distribution Sewers (by Census tract)	X			EPA Envirofacts Data Warehouse LRT Tool (2001)	State, county, or local sewer commission/department
Wastewater Treatment Plants		X		EPA Envirofacts Data Warehouse LRT Tool (2001)	State EMA
Wastewater Vaults and Control Stations		X		EPA Envirofacts Data Warehouse LRT Tool (2001)	State EMA
Wastewater Lift Stations		X		EPA Envirofacts Data Warehouse LRT Tool (2001)	State EMA
Wastewater System Facilities	X		X	EPA Envirofacts Data Warehouse LRT Tool (2001)	State EMA
Electric Power	X		X	EPA Envirofacts Data Warehouse LRT Tool (2001)	State and local fire departments, environmental agencies, State EMA and LEPC, private companies
Communication Central Offices and Switching Stations		X		Broadcast Auxiliary Microwave File, FCC (2001)	State and local fire departments, environmental agencies, State EMA and LEPC, private companies
Communication Vaults and Control Stations		X		Broadcast Auxiliary Microwave File, FCC (2001)	State and local fire departments, environmental agencies, State EMA and LEPC, private companies
Communication Broadcast Facility		X		Broadcast Auxiliary Microwave File, FCC (2001)	Electronic Yellow Pages
Communications	X		X	Broadcast Auxiliary Microwave File, FCC (2001)	Electronic Yellow Pages
Demographics	X		X	U.S. Census Bureau and Dun & Bradstreet (2000)	Regional and local planning commissions Tax assessor's offices, zoning departments, regional and local planning commissions

Table Set 2: Inventory Data Fields

Inventory Category	General Fields	Hazards-Specific Fields		
		Earthquake	Flood	Hurricane
Essential Facilities				
Emergency Response	ID Number, Building Class, Tract, Name, Address, City, Zip Code, State, Contact, Phone Number, Year Built, Number of Stories, Replacement Cost, Backup Power, Shelter Capacity, Building Area, Kitchen, Latitude, Longitude, Comment	Building Type, Building Quality, Design Level, Soil Type, Liquefaction Susceptibility, Landslide Susceptibility, Water Depth	Design Level, Foundation Type, First Floor Height, Building Damage Fnld, Content Damage Fnld, Flood Protection, BU Power	Hurricane Building Type, Hurricane Scheme Name
Fire Stations	ID Number, Building Class, Tract, Name, Address, City, Zip Code, State, Contact, Phone Number, Year Built, Number of Stories, Backup Power, Shelter Capacity, Building Area, Kitchen, Number of Trucks, Latitude, Longitude, Comment	N/A	N/A	Hurricane Building Type, Hurricane Scheme Name
Medical Care	ID Number, Building Class, Tract, Name, Address, City, Zip Code, State, Contact, Phone Number, Use, Year Built, Number of Stories, Replacement Cost, Backup Power, Number of Beds, AHA ID, Latitude, Longitude, Comment	Building Type, Building Quality, Design Level, Soil Type, Liquefaction Susceptibility, Landslide Susceptibility, Water Depth	Design Level, Foundation Type, First Floor Height, Building Damage Fnld, Content Damage Fnld, Flood Protection, BU Power	Hurricane Building Type, Hurricane Scheme Name
Police Stations	ID Number, Building Class, Tract, Name, Address, City, Zip Code, State, Contact, Phone Number, Year Built, Number of Stories, Cost, Backup Power, Shelter Capacity, Building Area, Kitchen, Latitude, Longitude, Comment	N/A	N/A	Hurricane Building Type, Hurricane Scheme Name
Schools	ID Number, Building Class, Tract, Name, Address, City, Zip Code, State, Contact, Phone Number, Year Built, Number of Stories, Replacement Cost, Number of Students, Backup Power, Shelter Capacity, Building Area, District, Kitchen, Latitude, Longitude, Comment	Building Type, Building Quality, Design Level, Soil Type, Liquefaction Susceptibility, Landslide Susceptibility, Water Depth	Design Level, Foundation Type, First Floor Height, Building Damage Fnld, Content Damage Fnld, Flood Protection, BU Power	Hurricane Building Type, Hurricane Scheme Name
High Potential Loss Facilities				
Dams	ID Number, Dam Class, Tract, Name, County Name, Owner, Cost, River, Near City, Distance City, Purpose, Year Completed, Dam Length, Dam Height, Structural Height, Max. Discharge, Hydro Height, Max Storage, Normal Storage, Surface Area, Drain Area, Hazard, EAP, Spill Type, Spill Width, Volume, NAT ID, Primary Agency, Latitude, Longitude, Comment	Soil Type, Liquefaction Susceptibility, Landslide Susceptibility, Water Depth	None	None

Inventory Category	General Fields	Hazards-Specific Fields		
		Earthquake	Flood	Hurricane
High Potential Loss Facilities (continued)				
Levees	ID Number, County FIP, County Name, Levee Name, Levee Width, Levee Height, Levee Crest, Normal Height, Owner, River, Near City, Distance City, Year Completed, Hazard, Comment	Soil Type, Liquefaction Susceptibility, Landslide Susceptibility, Water Depth	None	None
Military Installations	ID Number, Building Class, Tract, Name, Address, City, Zip Code, State, Contact, Phone Number, Year Built, Number of Stories, Owner, Shelter Capacity, Use, Building Cost, Content Cost, Latitude, Longitude, Comment	Building Type, Building Quality, Design Level, Soil Type, Liquefaction Susceptibility, Landslide Susceptibility, Water Depth	None	None
Nuclear Power Facilities	ID Number, Building Class, Tract, Name, Address, City, Zip Code, State, Owner, Contact, Phone Number, Year Built, Number of Stories, Replacement Cost, Latitude, Longitude, Capacity, Comment	Building Type, Building Quality, Design Level, Soil Type, Liquefaction Susceptibility, Landslide Susceptibility, Water Depth	None	None
Hazardous Materials Facilities	ID Number, Building Class, Tract, Name, Address, City, State, Zip Code, Contact, Cas#, Chemical Name, Chemical Quantity, SIC Code, Year Built, EPA ID, Permit Amount, Latitude, Longitude, Comment	Building Type, Building Quality, Design Level, Foundation Type, Soil Type, Liquefaction Susceptibility, Landslide Susceptibility, Water Depth	None	None
Transportation Systems				
Highway Segments	Number, Segment Class, County FIP, Name, Owner, Length, Traffic, Cost, Number of Lanes, Pavement, Width, Capacity, Comment	None	None	None
Highway Bridges	ID Number, Bridge Class, Tract, Name, Owner, Bridge Type, Width, Number of Spans, Length, Maximum Span Length, Skew Angle, Seat Length, Seat Width, Year Built, Year Remodeled, Pier Type, Foundation Type, Scour Index, Traffic, Traffic Index, Condition, Cost, Latitude, Longitude, Comment	Soil Type, Liquefaction Susceptibility, Landslide Susceptibility, Water Depth	Elevation	None
Highway Tunnels	ID Number, Tunnel Class, Tract, Name, Owner, Type, Width, Length, Year Built, Traffic, Cost, Latitude, Longitude, Comment	Soil Type, Liquefaction Susceptibility, Landslide Susceptibility, Water Depth	None	None
Rail Segments	ID Number, Segment Class, County FIP, Name, Owner, Length, Traffic, Cost, Number of Tracks, Comment	None	None	None
Rail Bridges	ID Number, Bridge Class, Tract, Name, Owner, Bridge Type, Width, Number of Spans, Length, Maximum Span Length, Skew Angle, Seat Length, Seat Width, Year Built, Year Remodeled, Pier Type, Foundation Type, Scour Index, Traffic, Traffic Index, Condition, Cost, Latitude, Longitude, Comment	Soil Type, Liquefaction Susceptibility, Landslide Susceptibility, Water Depth	Elevation	None
Rail Tunnels	ID Number, Tunnel Class, Tract, Name, Owner, Type, Width, Length, Year Built, Traffic, Cost, Latitude, Longitude, Comment	Soil Type, Liquefaction Susceptibility, Landslide Susceptibility, Water Depth	None	None
Rail Facilities	ID Number, Facility Class, Tract, Name, Address, City, Zip Code, State, Owner, Contact, Phone Number, Use, Year Built, Cost, Backup Power, Traffic, Latitude, Longitude, Comment	Anchor, Foundation Type, Building Type, Design Level, Soil Type, Liquefaction Susceptibility, Landslide Susceptibility, Water Depth	None	None
Light Rail Segments	ID Number, Segment Class, County FIPS, Name, Owner, Length, Traffic, Cost, Number of Tracks, Comment	None	None	None
Light Rail Bridges	ID Number, Bridge Class, Tract, Name, Owner, Bridge Type, Width, Number of Spans, Length, Maximum Span Length, Skew Angle, Seat Length, Seat Width, Year Built, Year Remodeled, Pier Type, Foundation Type, Scour Index, Traffic, Traffic Index, Condition, Cost, Latitude, Longitude, Comment	Soil Type, Liquefaction Susceptibility, Landslide Susceptibility, Water Depth	Elevation	None
Light Rail Tunnels	ID Number, Tunnel Class, Tract, Name, Owner, Type, Width, Length, Year Built, Traffic, Cost, Latitude, Longitude, Comment	Soil Type, Liquefaction Susceptibility, Landslide Susceptibility, Water Depth	None	None
Light Rail Facilities	ID Number, Facility Class, Tract, Name, Address, City, Zip Code, State, Owner, Contact, Phone Number, Use, Year Built, Number of Stories, Cost, Backup Power, Traffic, Latitude, Longitude, Comment	Anchor, Foundation Type, Building Type, Building Quality, Design Level, Soil Type, Liquefaction Susceptibility, Landslide Susceptibility, Water Depth	None	None
Bus	ID Number, Facility Class, Tract, Name, Address, City, Zip Code, State, Owner, Contact, Phone Number, Use, Year Built, Cost, Backup Power, Traffic, Latitude, Longitude, Comment	Anchor, Foundation Type, Building Type, Building Quality, Design Level, Soil Type, Liquefaction Susceptibility, Landslide Susceptibility, Water Depth	None	None
Port	ID Number, Facility Class, Tract, Name, Address, City, Zip Code, State, Owner, Contact, Phone Number, Use, Year Built, Backup Power, Cost, Capacity, Number of Berths, Number of Cranes, Latitude, Longitude, Comment	Anchor, Foundation Type, Building Type, Building Quality, Design Level, Soil Type, Liquefaction Susceptibility, Landslide Susceptibility, Water Depth	None	None

Inventory Category	General Fields	Hazards-Specific Fields		
		Earthquake	Flood	Hurricane
Transportation Systems (continued)				
Ferry	ID Number, Facility Class, Tract, Name, Address, City, Zip Code, State, Owner, Contact, Phone Number, Use, Year Built, Number of Stories, Cost, Backup Power, Traffic, Latitude, Longitude, Comment	Anchor, Foundation Type, Building Type, Building Quality, Design Level, Soil Type, Liquefaction Susceptibility, Landslide Susceptibility, Water Depth	None	None
Airport Facilities	ID Number, Facility Class, Tract, Name, Address, City, Zip Code, State, Owner, Contact, Phone Number, Use, Year Built, Cost, Cargo, Number of Flights, Number of Passengers, Backup Power, Latitude, Longitude, Comment	Anchor, Foundation Type, Building Type, Building Quality, Design Level, Soil Type, Liquefaction Susceptibility, Landslide Susceptibility, Water Depth	None	None
Airport Runways	ID Number, Facility Class, Tract, Name, Airport ID, Runway Length, Cost, Capacity, Pavement, Latitude, Longitude, Comment	Soil Type, Liquefaction Susceptibility, Landslide Susceptibility, Water Depth	None	None
Utility Systems				
Potable Water Pipelines	ID Number, Pipeline Class, County FIPS, Name, Owner, Material, Diameter, Pipe Length, Joint, Year Built, Cost, Source ID, Comment	None	None	None
Potable Water Distribution Pipes	Tract, Ductile Pipe, Brittle Pipe, Total Pipe, Presented by Census tract	None	N/A	None
Potable Water Distribution Pipes	ID Number, Name, Address, City, Zip Code, State, Owner, Contact, Phone Number, Class, Description, Usage, Cost, Year Built, Stories, Year Upgraded, System ID, G Class, Backup Power, Capacity, Demand, Latitude, Longitude, Comment	N/A	Flood Protection, Equipment Height, Foundation Type	N/A
Potable Water Control Vaults & Control Stations	ID Number, Name, Address, City, Zip Code, State, Owner, Contact, Phone Number, Class, Description, Usage, Cost, Year Built, Stories, Year Upgraded, System ID, G Class, Backup Power, Capacity, Demand, Latitude, Longitude, Comment	N/A	Flood Protection, Equipment Height, Foundation Type	N/A
Potable Water Network System Tanks	ID Number, Name, Address, City, Zip Code, State, Owner, Contact, Phone Number, Class, Description, Usage, Cost, Year Built, Stories, Year Upgraded, System ID, G Class, Backup Power, Capacity, Demand, Latitude, Longitude, Comment	N/A	Flood Protection, Equipment Height, Foundation Type	N/A
Potable Water Network System Wells	ID Number, Name, Address, City, Zip Code, State, Owner, Contact, Phone Number, Class, Description, Usage, Cost, Year Built, Stories, Year Upgraded, System ID, G Class, Backup Power, Capacity, Demand, Latitude, Longitude, Comment	N/A	Flood Protection, Equipment Height, Foundation Type	N/A
Potable Water System Facilities	ID Number, Facility Class, Tract, Name, Address, City, Zip Code, State, Owner, Contact, Phone Number, Use, Year Built, Number of Stories, Cost, System ID, G Class, Backup Power, Year Upgraded, Capacity, Demand, Latitude, Longitude, Comment	Building Type, Building Quality, Design Level, Soil Type, Liquefaction Susceptibility, Landslide Susceptibility, Water Depth	Flood Protection, Equipment Height, Foundation Type	None
Wastewater Pipelines	ID Number, Pipeline Class, County FIPS, Name, Owner, Material, Diameter, Pipe Length, Joint, Year Built, Cost, Source ID, Comment		None	None
Wastewater Sewers	Tract, Ductile Pipe, Brittle Pipe, Total Pipe		N/A	None
Wastewater Treatment Plants	ID Number, Facility Class, Name, Address, City, Zip Code, State, Owner, Contact, Phone Number, Usage, Facility Cost, Year Built, Number of Stories, G Class, System ID, Backup Power, Capacity, Demand, Latitude, Longitude, Comment	N/A	Flood Protection, Equipment Height, Foundation Type	N/A
Wastewater Vaults & Control Stations	ID Number, Facility Class, Name, Address, City, Zip Code, State, Owner, Contact, Phone Number, Description, Usage, Facility Cost, Year Built, Number of Stories, G Class, System ID, Year Upgraded, Backup Power, Capacity, Demand, Latitude, Longitude, Comment	N/A	Flood Protection, Equipment Height, Foundation Type	N/A
Wastewater Lift Stations	ID Number, Facility Class, Name, Address, City, Zip Code, State, Owner, Contact, Phone Number, Description, Usage, Facility Cost, Year Built, Number of Stories, G Class, System ID, Year Upgraded, Backup Power, Capacity, Demand, Latitude, Longitude, Comment	N/A	Flood Protection, Equipment Height, Foundation Type	N/A
Wastewater System Facilities	ID Number, Facility Class, Tract, Name, Address, City, Zip Code, State, Owner, Contact, Phone Number, Use, Year Built, Number of Stories, Cost, System ID, G Class, Backup Power, Year Upgraded, Capacity, Demand, Latitude, Longitude, Comment	Anchor, Foundation Type, Building Type, Building Quality, Design Level, Soil Type, Liquefaction Susceptibility, Landslide Susceptibility, Water Depth	N/A	None
Crude and Refined Oil Pipelines	ID Number, Pipeline Class, County FIPS, Name, Owner, Material, Diameter, Pipe Length, Joint, Year Built, Cost, Source ID, Comment	None	None	None
Oil Refineries	ID Number, Facility Class, Tract, Name, Address, City, Zip Code, State, Owner, Contact, Phone Number, Use, Year Built, Number of Stories, Cost, System ID, G Class, Backup Power, Capacity, Demand, Latitude, Longitude, Comment	N/A	Flood Protection, Equipment Height, Foundation Type	N/A
Oil Pumping Plants	ID Number, Facility Class, Tract, Name, Address, City, Zip Code, State, Owner, Contact, Phone Number, Description, Use, Year Built, Number of Stories, Cost, Backup Power, Capacity, Demand, Latitude, Longitude, Comment	N/A	Flood Protection, Equipment Height, Foundation Type	N/A

Inventory Category	General Fields	Hazards-Specific Fields		
		Earthquake	Flood	Hurricane
Utility Systems (continued)				
Oil Tank Farm	ID Number, Facility Class, Tract, Name, Address, City, Zip code, State, Owner, Contact, Phone Number, Description, Use, Year Built, Number of Stories, Cost, Backup Power, Capacity, Demand, Latitude, Longitude, Comment	N/A	Flood Protection, Equipment Height, Foundation Type	N/A
Oil Control Vaults and Control Stations	ID Number, Facility Class, Tract, Name, Address, City, Zip code, State, Owner, Contact, Phone Number, Description, Use, Year Built, Number of Stories, Cost, Backup Power, Capacity, Latitude, Longitude, Comment	N/A	Flood Protection, Equipment Height, Foundation Type	N/A
Crude and Refined Oil Pipeline Facilities	ID Number, Facility Class, Tract, Name, Address, City, Zip code, State, Owner, Contact, Phone Number, Use, Year Built, Cost, Backup Power, Capacity, Latitude, Longitude, Comment	Anchor, Foundation Type, Building Type, Building Quality, Design Level, Soil Type, Liquefaction Susceptibility, Landslide Susceptibility, Water Depth	N/A	None
Natural Gas Pipelines	ID Number, Pipeline Class, County FIPS, Name, Owner, Material, Diameter, Pipe Length, Joint, Year Built, Cost, Source ID, Comment	None	None	None
Natural Gas Distribution Pipes	Tract, Ductile Pipe, Brittle Pipe, Total Pipe	None	N/A	None
Natural Gas Compressor Plants	ID Number, Facility Class, Name, Address, City, Zip Code, State, Owner, Contact, Phone Number, Description, Use, Installation Year, Number of Stories, Cost, Backup Power, Capacity, Latitude, Longitude, Comment	N/A	Flood Protection, Equipment Height, Foundation Type	N/A
Natural Gas Control Vaults and Control Stations	ID Number, Facility Class, Name, Address, City, Zip Code, State, Owner, Contact, Phone Number, Description, Use, Installation Year, Number of Stories, Cost, Backup Power, Capacity, Latitude, Longitude, Comment	N/A	Flood Protection, Equipment Height, Foundation Type	N/A
Natural Gas Facilities	ID Number, Facility Class, Tract, Name, Address, City, Zip Code, State, Owner, Contact, Phone Number, Use, Year Built, Cost, Number of Stories, Backup Power, Capacity, Latitude, Longitude, Comment	Building Type, Building Quality, Design Level, Soil Type, Liquefaction Susceptibility, Landslide Susceptibility, Water Depth	N/A	None
Electric Power Plants	ID Number, Facility Class, Name, Address, City, Zip Code, State, Owner, Contact, Phone Number, Description, Use, Year Built, Number of Stories, Cost, Capacity, Latitude, Longitude, Comment	N/A	Flood Protection, Equipment Height, Foundation Type	N/A
Electric Power Substations	ID Number, Facility Class, Name, Address, City, Zip Code, State, Owner, Contact, Phone Number, Description, Use, Year Built, Number of Stories, Cost, Capacity, Latitude, Longitude, Comment	N/A	Flood Protection, Equipment Height, Foundation Type	N/A
Electric Power	ID Number, Facility Class, Tract, Name, Address, City, Zip Code, State, Owner, Contact, Phone Number, Use, Year Built, Number of Stories, Capacity, Cost, Latitude, Longitude, Comment	Anchor, Foundation Type, Building Type, Building Quality, Design Level, Soil Type, Liquefaction Susceptibility, Landslide Susceptibility, Water Depth	N/A	None
Communication Central Offices and Switching Stations	ID Number, Facility Class, Name, Address, City, Zip Code, State, Owner, Contact, Phone Number, Description, Use, Cost, Installation Year, Backup Power, Latitude, Longitude, Comment	N/A	None	N/A
Communication Vaults and Control Stations	ID Number, Facility Class, Name, Address, City, Zip Code, State, Owner, Contact, Phone Number, Description, Use, Cost, Installation Year, Backup Power, Latitude, Longitude, Comment	N/A	None	N/A
Communication Broadcast Facility	ID Number, Facility Class, Name, Address, City, Zip Code, State, Owner, Contact, Phone Number, Description, Use, Cost, Installation Year, Backup Power, Latitude, Longitude, Comment	N/A	None	N/A
Communications	ID Number, Facility Class, Tract, Name, Address, City, Zip Code, State, Owner, Contact, Phone Number, Use, Year Built, Cost, Backup Power, Latitude, Longitude, Comment	Anchor, Foundation Type, Building Type, Building Quality, Design Level, Soil Type, Liquefaction Susceptibility, Landslide Susceptibility, Water Depth	N/A	None
Demographics	Block, Population, Households, Group Quarters, Population Age Distribution, Male Population, Female Population, Race Distribution, Income, Daytime Residency, Night Residency, Hotel, Visitor, Working Com, Working Ind, Commuting 5pm, Number of Home Owners, Number of Renters, Number of Vacant Homes, Building Age, Median Age, Average Rent, Average Value, School Enrollment	None	None	None
General Building Stock	Exposure, Count, and Square Footage by General Occupancy, Specific Occupancy, and Building Type	None	None	None
User Defined	ID Number, Occupancy, Tract, Name, Address, City, Zip code, State, Contact, Phone Number, Year Built, Cost, Backup Power, Number of Stories, Area, Content Cost, Shelter Capacity, Latitude, Longitude, Comment	Building Type, Building Quality, Design Level, Soil Type, Liquefaction Susceptibility, Landslide Susceptibility, Water Depth	Design Level, Foundation Type, First Floor Height, Flood Protection, County	Wind Building Type, Wind Building Scheme Name

Appendix B Disaster Data Resources Links

This appendix lists a sample of disaster data resources available online. The first four resources are discussed in detail in the Data Resources section of this report. The other resources listed in this appendix are either single disaster databases or collections of disaster databases.

Links from Data Resources Section of Report

The EPA's CAMEO program
http://www.epa.gov/ceppo/cameo/what.htm

State of Florida real-time shelter database
http://www.eoconline.org/EM_Live/shelter.nsf

State of Florida real-time road status database
http://www.eoconline.org/EM_Live/roadstat.nsf

Southern California Earthquake Data Center
http://www.data.scec.org/index.html

Disaster Database Links

National Incident Management System
http://www.fema.gov/nims/

FEMA disaster photo library
http://www.photolibrary.fema.gov/photolibrary/index.jsp

National bridge inventory
http://www.nationalbridgeinventory.com/new_page_1.htm

EM-DAT, the international disaster database homepage
http://www.em-dat.net/

Disaster Database Collections Links

Comparison of EM-DAT and DesInventar disaster databases
http://www.desinventar.org/en/proyectos/lared/comparacion/

DEMIN database list
http://ccs.tamu.edu/homeland_security/index_home.html

EQNET list of disaster databases weblinks
http://128.205.131.100:591/FMPro?-db=eqnetdb.fp3&-lay=index&-format=categories.html&-error=categories.html&-max=10&-sortfield=finger&-sortorder=ascend&-op=cn&resourceCat=databases&-token=Databases&-find

Appendix C Workshop Planning Committee Members, Speakers, and Facilitators

This appendix lists the individuals involved in the Workshop Planning Committee, the workshop speakers, and the workshop facilitators.

Workshop Planning Committee Members

Dr. Ken Taylor, Director
North Carolina Emergency Management, ktaylor@ncem.org

Dr. Edd Hauser, Director, Center for Transportation Policy Studies
University of North Carolina at Charlotte, ehauser@email.uncc.edu

Dr. Stephen Meinhold, Associate Professor, Department of Political Science
University of North Carolina at Wilmington, meinholds@uncw.edu

Dr. Debra Laefer, Lecturer, University College Dublin, debra.laefer@ucd.ie

Dr. William Rasdorf, Professor
Department of Civil, Construction and Environmental Engineering
North Carolina State University, rasdorf@eos.ncsu.edu

Elizabeth Harris, Research Assistant
Department of Civil, Construction and Environmental Engineering
North Carolina State University, eagrafpe@unity.ncsu.edu

Workshop Speakers

Russ Lea, Vice President for Research and Sponsored Programs, University of North Carolina Board of Governors, Office of the President

R. Jay Love, Senior Principal, Degenkolb Engineers, member EERI

Dr. Ken Taylor, Director, North Carolina Emergency Management

Workshop Facilitators

Yellow Group: Hurricane and Tornado Wind
Facilitators: R. Jay Love and Dr. Stephen Meinhold

Green Group: Ice Storm
Facilitator: Dr. Gavin Smith, Program Manager, PBS&J

Blue Group: Flood
Facilitator: Tim Johnson, Director, Center for Geographic Information and Analysis

Red Group: Explosion
Facilitator: Debra Laefer

Appendix D Participant Invitation Letter

This appendix contains the invitation letter for the disaster data workshop.

August 20, 2004

Dear Hazards Researcher/Professional:

We are pleased to invite you to the a workshop sponsored by North Carolina State University (NCSU), the North Carolina Institute of Disaster Studies (IDS), and North Carolina Division of Emergency Management (NCEM). The workshop theme is **"Determining Disaster Data Needs for a Multi-Stage, Multi-Disaster Context,"** to be held Thursday and Friday, November 4 and 5, 2004 at the Brownstone Hotel adjacent to the NCSU campus in Raleigh.

As an invited participant we are asking you to attend the workshop and participate by sharing your expertise in the handling of disaster-related data. All participants are individuals who are involved in disaster preparedness either before, during or after an event. By including participants from all phases of disaster management, we will be able to define the data needs, resources and gaps throughout the disaster management cycle. Many of you have been invited because of your previous participation in IDS and NCEM's disaster management efforts.

The goals for the workshop are as follows:

- Define information needs to support a disaster management system
- Establish the quality, format and location of the data resources involved
- Identify data gaps and possibilities to improve data collection and dissemination methods
- Verify commonality in disaster information among multiple disaster types
- Define objectives for pre-disaster organized disaster data gathering teams

Participants will breakout into small groups of approximately 8-12 members to discuss information needs, existing data resources, data gaps, and disaster data dissemination. Because disaster information is short-lived, opportunities to add additional data collecting capacity inexpensively to the existing data collecting infrastructure, such as temperature monitoring on bridges and building inspector records, will be the focus of discussion.
The disaster workshop will also include a visit to the Constructed Facilities Laboratory (CFL) on the NCSU Centennial Campus in order to demonstrate some of the hazards research resources available in North Carolina.

The major proposed outcome of this workshop is a summary report of the discussion conclusions, which will be sent to all of the participants and available to the disaster management community via a workshop website. The results of research associated with this workshop will verify the viability and usefulness of a common multi-stage, multi-disaster data set through IDS, NCEM, and others in the disaster community.

Registration costs are covered by a National Science Foundation grant and as a result there is no registration fee for the workshop. The workshop will begin with registration from 8:30 to 9:00 am on Thursday and will conclude at 12:30pm on Friday. Continental breakfast will be provided on Thursday and Friday, and a buffet lunch will be provided on Thursday.

This is an exciting opportunity for you to play a role in improving disaster data management in North Carolina. Please let us know at your earliest convenience but no later than Wednesday, September 22 of your ability to participate in the workshop. A registration form is attached where you can indicate whether you will be attending. If you cannot attend, we request that you forward this invitation to another colleague in your office/association who would be an appropriate participant. Send all workshop correspondence to Elizabeth Harris at eagrafpe@ncsu.edu, 919.836.1989, or FAX to her at 919.515.7908. We look forward to hearing from you.

Best regards,

Dr. Debra Laefer
Assistant Professor
Department of Civil, Construction, and Environmental Engineering
North Carolina State University
919-515-7631
dflaefer@ncsu.edu

Organizing Committee:

Dr. Ken Taylor, Director, North Carolina Division of Emergency Management
Institute of Disaster Studies:
Dr. Edd Hauser, Director, Center for Transportation Policy Studies, UNC Charlotte
Dr. Stephen Meinhold, Department of Political Science, UNC Wilmington
North Carolina State University:
Dr. Debra Laefer, Department of Civil, Construction, and Environmental Engineering
Dr. William Rasdorf, Department of Civil, Construction, and Environmental Engineering

Appendix E Workshop Participants List

This appendix lists each workshop participant's name, the organization they represent, their position in the organization, their email address, and the workshop group in which they participated.

	Participant	Position	Organization Name	Email Address	Workshop Group
1	Katina Blue	Director of Vendor Relations	Business Continuity Planners of the Carolinas	katina_blue@ncsu.edu	wind
2	Jamie Kruse	Professor	Center for Natural Hazards Mitigation	krusej@mail.ecu.edu	wind
3	R. Jay Love	Senior Principal	Degenkolb Engineers/EERI	rjlove@degenkolb.com	wind
4	Dr.Steven Meinhold	Professor	Institute of Disaster Studies/ UNC-W	meinholds@uncwil.edu	wind
5	Chris Crew	Mitigation Specialist	NC Emergency Management Division	jcrew@ncem.org	wind
6	Brenda M. Jones	Executive Assistant	NC Emergency Management Division	bmjones@ncem.org	wind
7	William Rasdorf	Professor	NCSU Dept. of Civil Engineering	rasdorf@eos.ncsu.edu	wind
8	Dr. Sethu Raman	Director and State Climatologist	State Climate Office of North Carolina	sethu_raman@ncsu.edu	wind
9	Ryan Boyles	Associate State Climatologist	State Climate Office of North Carolina	ryan_boyles@ncsu.edu	wind
10	Steve Garrett	President	Wake Canine Search & Rescue	sgarrett@ncem.org	wind
11	Russ Lea	VP for Research and Sponsored Programs	UNC Board of Governors, Office of the President	rlea@northcarolina.edu	none - speaker
12	Elizabeth Harris	Graduate Research Assistant	NCSU Dept. of Civil Engineering	eagrafpe@ncsu.edu	none - floater
13	Sherry Elmes	Associate Director	Center for Transportation Studies	smelmes@uncc.edu	ice
14	Dr. Elizabeth Layman	Chair, ECU Dept. of Health Services and Information Management	ECU Department of Health Services and Information Management	laymane@mail.ecu.edu	ice
15	Dr. Ken Taylor	Director	NC Emergency Management Division	ktaylor@ncem.org	ice
16	Carla Woodlief	Computing Consultant	NC Emergency Management Division	cwoodlief@ncem.org	ice
17	Chris Call	Hazard Mitigation	NC Emergency Management Division	ccall@ncem.org	ice
18	Scott J. Galbraith	Training Manager	NC Emergency Management Division	sgalbraith@ncem.org	ice
19	Dr. Gavin Smith	Program Manager	PBS&J	GPSmith@pbsj.com	ice
20	Tim Johnson	Director	Center for Geographic Information and Analysis	tim.r.johnson@ncmail.net	flood
21	Dr. Edd Hauser	Director	Center for Transportation Studies	ehauser@uncc.edu	flood
22	Deborah Cooley-Godwin	Hazard Mitigation	NC Emergency Management Division	dcooley-godwin@ncem.org	flood
23	Todd Owen	Project Implementation Coordinator	NC Emergency Management Division	towen@ncem.org	flood
24	Darlene M. Johnson	Emergency Services Coordinator	NC Emergency Management Division	djohnson@ncem.org	flood
25	David Herlong		NC Floodplain Mapping Program	dherlong@ncem.org	flood
26	Dr. Sarah Kirby	Associate Prof. and Housing Specialist	NCSU Dept. of Family and Consumer Sciences	sarah_kirby@ncsu.edu	flood
27	John Spurell	Senior Policy Analyst	North Carolina League of Municipalities	jspurrel@nclm.org	flood
28	Tommie Ann Styons	Division Chief	Raleigh Fire Department	tommie.styons@ci.raleigh.nc.us	flood
29	David Godshalk	Professor Emeritus	UNC-CH Dept. of City and Regional Planning/IDS	dgod@email.unc.edu	flood
30	Randy Mundt	State Hazard Mitigation Officer	NC Emergency Management Division	rmundt@ncem.org	explosion
31	Steven Davis	Infrastructure Manager	NC Emergency Management Division	sdavis@ncem.org	explosion
32	Ken Davis	Manager, Logistics Support Branch	NC Emergency Management Division	kdavis@ncem.org	explosion
33	Debra Laefer	Lecturer	NCSU/UCD	debra.laefer@ucd.ie	explosion
34	Bill Bristle	Captain - HazMat Team	Raleigh Fire Department	william.bristle@ci.raleigh.nc.us	explosion
35	Lt. Brad Ward	Information Management Unit Executive Officer	NC State Highway Patrol		explosion

Appendix F Workshop Agenda

DETERMINING DISASTER DATA NEEDS FOR A MULTI-STAGE, MULTI –DISASTER CONTEXT

Workshop Agenda

THURSDAY, NOVEMBER 4: ***Data Needs, Resources and Dissemination in North Carolina***

8:00 a.m. **Workshop Registration and CONTINENTAL BREAKFAST**

9:00 a.m. **Opening Remarks (Sessions Room)**

Dr. Debra Laefer, *NCSU*
Dr. Ken Taylor, *Director, NC Emergency Management*
Dr. Edd Hauser, *UNC Charlotte, NC Institute of Disaster Studies (IDS)*

9:10 a.m. **Welcoming Remarks**

Dr. Russ Lea, *UNC Office of the President and NC IDS*

9:20 a.m. **Workshop Orientation and Goals**

Elizabeth Harris, *NCSU*

9:30 a.m. **EERI: Learning from Earthquakes Program (LFE)**

R. Jay Love, *Chair, LFE Advisory Committee, Degenkolb Engineers*

10:00 a.m. **COFFEE BREAK**

10:15 a.m. **Data Needs – Small Group Discussions (Break-out Rooms)**

Workshop participants will be assigned to four groups of approximately 10 participants each. The groups will break-out into separate rooms and first review completed earthquake disaster data needs matrices as an example and modify them according to North Carolina-specific data needs and disaster management organizations. Each group will then be assigned a different disaster and will complete the data needs matrices in terms of specific data needs in North Carolina. (90 minutes)

1. Yellow Group — Facilitators: R. Jay Love and Stephen Meinhold
   Disaster: High Wind Event
2. Green Group — Facilitator: Gavin Smith
   Disaster: Ice Storm
3. Blue Group — Facilitator: Tim Johnson
   Disaster: Flood
4. Red Group — Facilitator: Debra Laefer
   Disaster: Explosion

11:45 a.m. **LUNCH**

12:15 p.m. **Presentation of Data Needs Group Discussions (during lunch)**

Group Facilitators will report on their group's modifications to the earthquake disaster data needs matrices and major findings on the data needs for their assigned disaster. Any interesting discussion, comments or questions will also be presented.

12:45 p.m. **Data Resources – Small Group Discussions (Break-out Rooms)**

The groups will switch their focus to the disaster data resources in North Carolina. They will begin by reviewing completed earthquake disaster data resources matrices as an example and modifying them according to North Carolina-specific data resources and disaster management organizations. Each group will then complete the data resources matrices in terms of specific data resources in North Carolina. (90 minutes)

2:15 p.m. **Presentation of Data Resources Discussion Results (Sessions Room)**

Group Facilitators will report on their group's modifications to the earthquake disaster data resources matrices and major findings on the data resources for their assigned disaster. Any interesting discussion, comments or questions will also be presented.

2:45 p.m. **COFFEE BREAK**

3:00 p.m. **Dissemination –Small Group Discussions (Break-out Rooms)**

The groups will switch their focus to dissemination of disaster-related data in North Carolina. They will begin by reviewing completed earthquake disaster data dissemination matrices as an example and modifying them according to North Carolina-specific data dissemination practices/procedures. Each group will then complete the data dissemination matrices in terms of specific data dissemination practices/procedures in North Carolina. (75 minutes)

4:15 p.m. **Presentation of Dissemination Discussion Results (Sessions Room)**

Group Facilitators will report on their group's modifications to the earthquake disaster dissemination matrices and major findings on data dissemination for their assigned disaster. Any interesting discussion, comments or questions will also be presented.

4:45 p.m. **Preview of Constructed Facilities Laboratory Tour**

Elizabeth Harris, *NCSU*

4:50 p.m. **Leave for Tour of Constructed Facilities Laboratory**

After Tour EVENING MEAL – on your own (a list of local restaurants in provided in your packet)

** There will be an informal workshop assessment over dinner for workshop facilitators and planning committee. All interested participants are also invited.*
Location: Rock-Ola Cafe, Mission Valley Shopping Center, off Avent Ferry Rd.

FRIDAY NOVEMBER 5: *Developing Statewide Coordination of Disaster Data in North Carolina*

8:00 a.m. **CONTINENTAL BREAKFAST**

8:50 a.m. **Introduction to Friday's Workshop Objectives (Sessions Room)**

Dr. William Rasdorf, NCSU

9:00 a.m. **Common Data Set – Small Group Discussions (Break-out Rooms)**

The four groups will break-out and be given copies of the data needs, resources, and dissemination matrices the group completed in Thursday's session as well as matrices from another group that investigated a different disaster. Groups will examine the matrices and assess if there are commonalties between the data needs, resources, and dissemination for the two disasters. The group can also discuss what common data should be included in a statewide clearinghouse.
(75 minutes)

10:15 a.m. **Presentation of Common Data Set Discussions (Sessions Room)**

Group Facilitators will report on the assessment of commonality in disaster data needs, resources, and dissemination completed by their group. Any interesting discussion on a statewide clearinghouse and other comments can also be presented.

10:45 a.m. **COFFEE BREAK**

11:00 a.m. **Presentation on Data Collection Teams for North Carolina (Sessions Room)**

Dr. Ken Taylor, *NC Emergency Management*

11:10 a.m. **Disaster Data Collection Teams Discussion (Sessions Room)**

Dr. Ken Taylor, *Moderator*

All workshop participants will complete a disaster data collection team skills form that will be collected.
The group will then discuss how the common data items identified through the discussions can be used to create an agenda for regional/statewide Disaster Data Collection teams. Potential members of such a team and areas where cost savings can occur will be identified. (70 minutes)

12:20 p.m. **Closing Remarks**

Dr. Stephen Meinhold, *UNC Wilmington, NC IDS*

12:30 p.m. **Adjournment of Workshop**

Appendix G Original Multi-Disaster Data Model List for Small Group Discussions

This appendix contains the original multi-disaster data model used in the workshop sessions on Thursday. It consists of four data areas, inventory data, damage data, population/human infrastructure, and response resources. For each data area, the associated disaster data items are given in the table.

Disaster Data Items	Item #
Inventory Data (compiled prior to event)	
population/demographics	1
buildings	2
roads	3
bridges	4
tunnels	5
water	6
sewer	7
power	8
telecommunications/IT	9
health facilities (hospitals, urgent care, etc.)	10
natural resources/environment (please specify)	11
Damage Data (compiled during and after event)	
buildings	12
roads	13
bridges	14
tunnels	15
water	16
sewer	17
power	18
telecommunications/IT	19
health facilities (hospitals, urgent care, etc.)	20
natural resources/environment (please specify)	21
Population/Human Infrastructure	
evacuated population	22
injuries/deaths and causes	23
displaced population	24
displaced businesses	25
impacted animals	26
Response resources	
personnel/special teams	27
food/goods	28
shelter capacity	29
vehicles/machinery/equipment	30
Other	31

Appendix H Participant Information Sheet

These two sheets were provided to each participant to explain to them the terms and procedures to be used in the workshop session discussions on Thursday.

Participant Information for Data Needs, Resources, and Dissemination Sessions

You will be assigned to one of the four groups below, according to the color of the sticker on your nametag. This will be your group for the break-out sessions.

Disasters assigned to groups

Yellow Group Facilitators: R. Jay Love and Stephen Meinhold
Disaster: High Wind Event

Green Group   Facilitator: Gavin Smith
Disaster: Ice Storm

Blue Group   Facilitator: Tim Johnson
Disaster: Flood

Red Group   Facilitator: Debra Laefer
Disaster: Explosion

Definitions of Terms Used

High Wind Event – Disaster where the primary damage is caused by high winds. Could be a hurricane or a tornado, but water and hail damage should NOT be considered by the group, just wind-caused damage.

Flood – Damage caused primarily by rising waters. Do not include other damage, such as wind.

Explosion – Damage is caused by an explosive device. Group can decide whether device was accidentally or intentionally detonated.

Ice Storm – Winter storm common in North Carolina where ½ inch or more ice forms on all outdoor surfaces.

Inventory Data – historical data collected prior to a disaster event that is available for use during all phases of the disaster cycle. The data may or may not have been originally collected with emergency management uses in mind.

General Procedure for each session:

Group members will introduce themselves and their emergency management interests. Review the given definitions/scope of your group's assigned disaster.

You will be given a sample earthquake building damage completed form (on orange paper) and will discuss ideas for modifying it to make it more relevant to North Carolina.

Next you will begin completing the discussion recording forms for the many data items/categories. Guidelines for completing these forms are given below.

Begin completing the applicable column in the discussion recording forms for the current session. Check off completed/partially completed forms on the large items list to keep track of group progress.

Totally blank forms are to used if you want/need to give more information about a data item/category.

Although your group's disaster might not be your primary hazard concern, your general local emergency management knowledge is helpful in completing these forms.

Guidelines for completing discussion recording forms:

- Only fill out the column for the current session
- Please make sure to fill out your group number (1-4) and disaster type on the form
- Participants should ask each other if they do not know certain information and pass the forms around the table, leaving spaces blank when they do not know.
- If you want to fill out a blank (no numbered item listed on it) form, please link the form to a broader data item/category on the main list. For example, if you are elaborating on inventory data for demographics, label the original form 1a and the new blank form 1b.
- Be specific to local, North Carolina methods and organizations, especially with the WHO of the data and how the data is shared between organizations.
- If a complicated question comes up that you cannot answer or understand, write it on the easel pad for follow-up during the session presentation.
- Any interesting discussions, comments, or recommendations can also be written on the easel pad for mention during the session presentation.
- If you feel that the discussion recording form format is restrictive to what you want to record, please record the information in any clear format of your choosing. The bottom row of each form is blank for you to use for any items you wish to add. The forms are a suggested model, not a final model.
- Please write legibly.

At the end of the session time the group should move to the session room from the break-out rooms and take a seat with the other groups for the presentations of group findings.

Facilitators will present their group's results in the way they/their group wishes. Each group should speak/present for approx. 5 minutes.

Appendix I Blank Small Group Discussion Recording Form

This appendix (two pages) contains the blank form given out to each workshop group on Thursday to record their discussion results for each data item.

WORKSHOP ON DETERMINING DISASTER DATA NEEDS FOR A MULTI-STAGE, MULTI –DISASTER CONTEXT

Small Group Discussion Recording Form

Disaster Type: ________________ **Group Number:** _____________

ITEM

		DATA NEEDS	DATA RESOURCES
For this item, WHAT are the...			
WHO is involved?	**Data Owner/Collector**		
	Data User(s)		
WHERE collect(ed)?			
WHEN collect(ed)?			
What is the data FORMAT? paper, verbal, photo, electronic (specify computer format), etc.			

*Please write legibly. Thank you.

Small Group Discussion Recording Form

Disaster Type: ________________ **Group Number:** _____________

ITEM

		DISSEMINATION / ACCESS
For this item, WHAT data is disseminated?		
WHO is involved?	**Data Owner/Collector**	
	Data User(s)	
TRANSFER METHOD via e-mail, phone, internal network, TV, radio, etc.		
WHEN disseminated?		
What is the data FORMAT? paper, verbal, photo, electronic (specify computer format), etc.		

*Please write legibly. Thank you.

Appendix J Sample Earthquake Small Group Discussion Recording Form

This appendix (two pages) contains a discussion recording form filled out for the damage to buildings data item for an earthquake disaster. This was given out to each workshop group on Thursday to serve as an example of a completed form.

WORKSHOP ON DETERMINING DISASTER DATA NEEDS FOR A MULTI-STAGE, MULTI –DISASTER CONTEXT

Small Group Discussion Recording Form

Disaster Type: EARTHQUAKE **Group Number:** ___N/A___

ITEM 12

Damage Data - buildings

		DATA NEEDS	DATA RESOURCES
For this item, WHAT are the...		Description of Building Damage, Total Estimated Loss, Functionality of Building, Construction Structural Framing Type and Materials, Building Age, # of stories	ATC-20, ATC-38, and HAZUS format datasets, Reconnaisance Team reports, building permits, tax records, Fire Insurance Atlas
WHO is involved?	**Data Owner/Collector**	Field Reconnaisance Teams (licensed civil/structural engineers)	Local municipalities, academic/research organizations, federal government
	Data User(s)	Earthquake researchers, emergency management professionals	Earthquake researchers, emergency management professionals
WHERE collect(ed)?		Building Sites within disaster area	Locations where earthquakes occured and field teams did reconnaisance, esp. California/West Coast
WHEN collect(ed)?		up to 3 months after event	up to 3 months after event, where event may have occurred 10 - 70 years ago
What is the data FORMAT? paper, verbal, photo, electronic (specify computer format), etc.		Paper Forms, Photos, Digital forms on PDA/Laptop	HAZUS format (paper/relational database), ATC-20 (or 38) paper forms, photographs (accompanied by detailed data), Paper maps and documents

*Please write legibly. Thank you.

Small Group Discussion Recording Form

Disaster Type: EARTHQUAKE **Group Number:** ___N/A__________

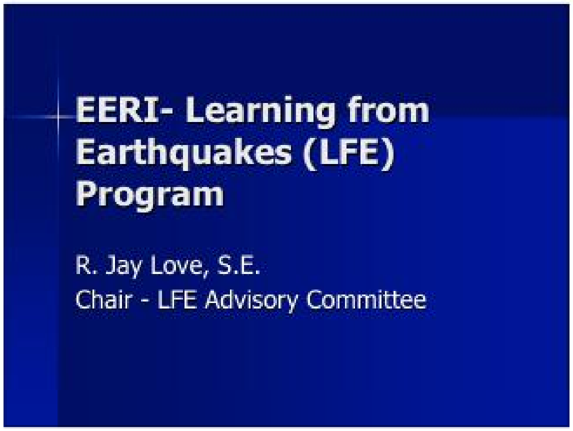
ITEM 12
Damage Data - buildings

		DISSEMINATION
For this item, WHAT data is disseminated?		ATC-20, ATC-38, and HAZUS format datasets, Reconnaisance Team reports, building permits, tax records, Fire Insurance Atlas
WHO is involved?	**Data Owner/Collector**	Local municipalities, academic/research organizations, federal government
	Data User(s)	Earthquake researchers, emergency management professionals
TRANSFER METHOD via e-mail, phone, internal network, TV, radio, etc.		Phone (quick telephone summaries immediately after event), Mail/pick up paper records, database transfer via network connection to repository or storage media (ex. CDs), Reports available through internet/in libraries/collections
WHEN disseminated?		Immediately after a disaster to 10 years later or more
What is the data FORMAT? paper, verbal, photo, electronic (specify computer format), etc.		Verbal, Paper, Electronic Databases, Photos

*Please write legibly. Thank you.

Appendix K Workshop Presentation by R. Jay Love of EERI

This appendix contains the presentation given by R. Jay Love on EERI's Learning from Earthquakes Program.




NSF Funded - 5 Year Grant
Program Components
– Reconnaissance Investigations
– Publications
– Reconnaissance training, including safety training


NSF Grant Components
– Small Grants Program
Beyond Reconnaissance Grants
Lessons Learned over Time
– Improving Data Collection
Incorporate new technologies and equipment to improve collection and data management


NSF Grant Components
– Data collection protocol workshop
– Field Guide
– Web site


Earthquake Reconnaissance
Initial overview observations
Multi-disciplinary teams


Post Earthquake Investigations
Produce early information for the professional & academic research community
Stimulate new areas of research
--NSF workshop for Turkey, Taiwan, Greece
--Beyond Reconnaissance Grant program


Post Earthquake Investigations
Change codes and modify practice
(SAC project—steel moment frames after Northridge)

Post Earthquake Investigations

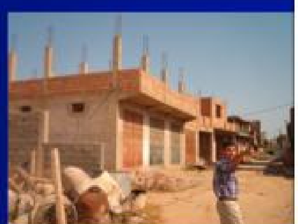
- Capture perishable data
- Effectiveness of response efforts
- Foster interdisciplinary exchange

Post Earthquake Investigations

- Avoids lengthy grant review process
- Provides laboratory to validate theories and practice

2003-04 LFE program sponsored:

- Bingöl, Turkey
- Boumerdes, Algeria
- Gujarat, India
- San Simeon, CA
- Bam, Iran
- Parkfield, CA
- Niigata Chuetsu, Japan

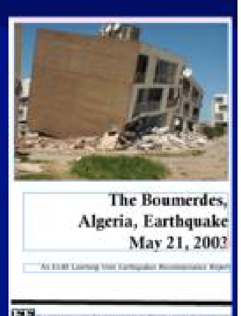


2003 LFE Program published:

- *EERI Newsletter Reports:*
  - Colima, Mexico
  - Bingöl, Turkey
  - Lefkada, Greece
  - Tokachi-Oki, Japan
- Coming Reports:
  - San Simeon, CA
  - Niigata Chuetsu

2003 LFE Program

- 5 reconnaissance reports in progress—*Earthquake Spectra* or stand-alone report format:
  - Molise, Italy
  - Denali, Alaska
  - Colima, Mexico
  - Boumerdes, Algeria
  - Gujarat, India
  - Bam, Iran
- *Lessons Learned over Time* reports
  - Adobe Construction in El Salvador

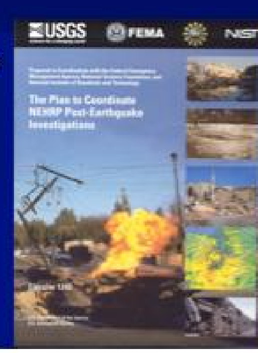


The Boumerdes, Algeria, Earthquake
May 21, 2003

EARTHQUAKE ENGINEERING RESEARCH INSTITUTE

"Plan to Coordinate NEHRP Post-Earthquake Investigations"

- USGS, FEMA, NSF, and NIST
- Circular 1242



The NERHP Plan

- Plan to coordinate domestic and foreign post-earthquake investigations supported by National Earthquake Hazards Reduction Program (NEHRP)
  - Framework to coordinate
  - Identifies Responsibilities of various organizations
  - Organized into three phases of activities

Phase I Time Frame

- Immediate to several days
  - USGS Incident report to notify emergency managers, NEHRP agencies
  - Establish a web site with links to earthquake-related web sites
  - Designate an NEHRP Investigations Coordinator
  - Organize a technical clearinghouse
  - Examine relevant factors for a NIST investigation

Phase II Time Frame

- Several Days to 1 Month
  - Investigations Coordinator convenes meeting to identify opportunities for rapid, concentrated data gathering and systematic collection of perishable data.
  - NEHRP convenes meeting to establish need for supplemental funding

Phase III Time Frame

- 1 Month to 5 years
  - Multidisciplinary Workshop on Investigation Priorities within 1 – 2 months to evaluate short and long term research.
  - Investigation Solicitations
  - Information Dissemination
    - Event summary with preliminary observations within 3 months for broad audience

Post-Earthquake Information Clearinghouse

Information Clearinghouse

- **In 1998 California formalized a process for a technical clearinghouse**
- Gather and share intelligence to aid government agencies, researchers and others in decision-making
- Place near the earthquake where field investigators meet nightly to review progress, organize and coordinate

Management Group in California

California OES
California Geological Survey (CGS)
EERI
U.S. Geological Survey (USGS)
Seismic Safety Commission

Participating Organizations

- Applied Technology Council
- CA Geological Survey
- CA OES
- CA Seismic Safety Commission
- Caltech
- CUREE
- EERI
- FEMA
- NASA
- PEER/NISEE
- So.Cal. EQ Center
- SEAOC
- ASCE - TCLEE
- UC Berkeley Seismo. Lab
- USGS
- WSSPC

Clearinghouse Functions

- Gather intelligence for regional emergency response (to REOC)
- Coordination / information point for incoming researchers
- Reduce pressure on local officials, emergency managers
- Coordinate information gathering
- Collect perishable data in more systematic manner
- Deploy volunteer contributors

Clearinghouse Services

- Field researcher check-in
  - Untested at this time
- Credentials to improve restricted area access
  - Untested at this time
- Daily de-briefing sessions
- Information from off-site organizations
- Updated damage maps

Virtual Clearinghouse

- Internet-based clearinghouse
- Replaces Clearinghouse for smaller events
- Supplements Clearinghouse for large events

How Does the Process Work?

Event

Team Selection Process 1-2 days

Field Recon-naissance 1-3 weeks

Public Briefings 2-3 months later

EERI Newsletter Within 2-3 months

Spectra Journal Within 12

Team Selection Process

Who decides level of response and team selection?

- LFE Advisory Committee
- EERI Executive Director
- LFE - Project Manager
- EERI Board of Directors

Decision to Send Teams

- Level of damage, type of structures, other interesting lessons (lifelines, emergency response, other)
- Other considerations: opportunities for collaboration, relevance of experience to U.S.

U.S. Earthquake

Minor damage
↓
Local member reconnaissance team
Virtual Clearinghouse
↓
EERI Newsletter and web report

Parkfield, CA 2004

San Simeon, CA 2003

Napa, CA 2000

U.S. Earthquake

Significant damage
↓
Full reconnaissance team investigation with clearinghouse
↓
EERI *Newsletter* and web report
↓
Earthquake Spectra or stand-alone reconnaissance report

Example:

Northridge, CA, 1994

Funding Support

- Limit team size; need to stretch budget as far as possible.
- Budgeted for up to three earthquakes per year

Team Organization

Team Leader

Discipline leaders:

earth sciences | geotech | lifelines | Struct.eng. | social sciences

Support:

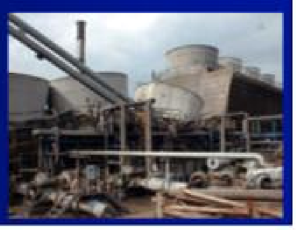
Logistics | IT specialist | Young Professionals

Others:

other teams | observers | contributors | affiliates

Team Leader

- Field experience with previous EERI team
- Lessons in his or her disciplinary area
- Strong management and leadership skills

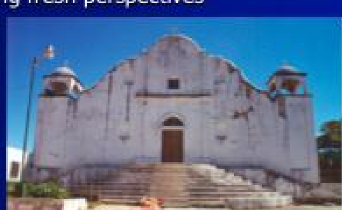


Specialists

- Depending on earthquake:
  - Bridges
  - Historic preservation
  - Cultural monuments
  - Tsunamis
  - Emergency Response

Young professionals

- Try to include 1 or 2 younger professionals
  - gain needed reconnaissance experience
  - bring fresh perspectives



IT Specialist(s)

- EERI member with IT background or emphasis-
  - Digital camera/video
  - PDA software/data collection
  - GPS
  - Communications
  - Remote sensing

Logistics Coordinators

- Local members asked to identify someone to function as logistics coordinator *OR*
- Team takes person dedicated to this function *OR*
- Team leader plays this role

Selection Considerations

- Knowledge of area
- Special characteristics of the event
- Availability
- Field experience
- No competing professional commitments
- EERI membership

Phase III Activities

- Consideration a second research team (different disciplines) after several months, possibly a year or more.

Reconnaissance process changing

- Instant notification via internet
  - USGS listserv
- Near-real time intensity mapping
  - USGS web-generated "shakemaps"
- Global communication
  - E-mail; colleagues with many contacts

Reconnaissance process changing

- Collaboration
  - Agreements between EERI and other societies of Earthquake Engineering (Example: Mexico)
  - More members with international experience, language skills

Reconnaissance process changing

- More information to manage and disseminate
  - Web-based
  - CDs (linking images, text, sound, video, background information, etc.)

Working Towards Systematic Data Collection

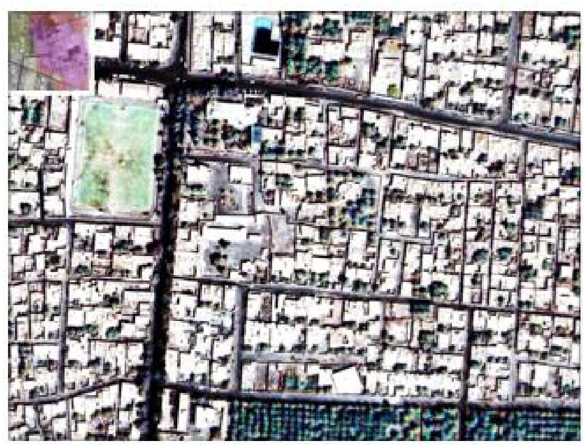
- Big Picture
  - Action Plan for Data Collection and Management—where we want to go from here
  - Data Collection Systems using PDAs/tablet PCs
  - Remote sensing technologies

Standardized data collection

- Useful for documentation and understanding of impacts of earthquake
- Use standard forms/electronic data collection system
- Clearinghouse data collection forms available on EERI web site www.eeri.org

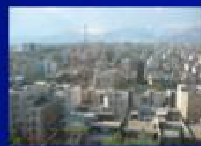
Remote Sensing

- Satellite Imagery
  - VIEWS – visualizing impact of earthquakes with satellites – ImageCat, MCEER
  - Geo-referenced data collection systems
- Overflights
- LIDAR mapping



Information technology in data collection

- Collect observations in electronic format
  - Use standard forms on PDAs or computers
  - Digital photos, video, sound files (voice recordings)
  - Notes, reports, maps
- "Digital Push-pin"
  - All electronic files geo-referenced to a digigeographic point



Expanded uses of GIS

- GIS-based map information with "digital push-pin" information
- Push-pins indicate which geographic points have information available
- Information collected in central, searchable GIS database

Electronic Data Collection

- Prototype system developed by Accela Wireless
- Data entered on iPACs or laptops
- Web-based data storage
- On-the-fly form modification capability

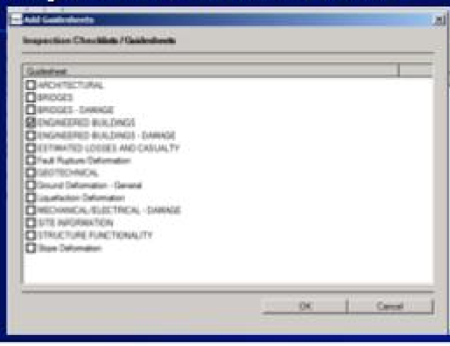
Reconnaissance Data Collection Forms

- Earth science data forms
- Building data forms

Building Structures—General Building Information

Ground Deformation Form

Inspection Guidesheets



Tests of Prototype Data Collection System

- Parkfield, California
  - IT Committee volunteers
  - ImageCat's VIEWS system
- Niigata Chuetsu

Thank you

- EERI.org

Appendix L EERI Data Collection Team Member Application

This appendix (three pages) contains the team member application used by EERI's Learning from Earthquakes Program.

EERI

LEARNING FROM EARTHQUAKES

TEAM MEMBER APPLICATION

The *Reconnaissance Team Members* must be interested and capable persons representing each of the various disciplines determined to be important for the specific earthquake. Field Investigators are expected to assess the nature and extent of damage, noting what did not fail as well as what did. In addition to documenting damage, field investigators should attempt to determine failure mode, factors that may have contributed to failure, what the implications of the damage are, and identify any secondary impacts. They should also note any recommendations that may improve seismic response. Those chosen for a Reconnaissance Team will be given guidelines detailing their specific obligations for that earthquake, including participation in subsequent briefing, etc. If you wish to be considered as a *Team Member* on a future EERI Earthquake Reconnaissance Team, please complete the application below:

NAME____
last first middle

AFFILIATION: ____

ADDRESS: ____
street city state zip code

PHONE: ________________ FAX: __________________ E-MAIL ADDRESS: __________________

Country(ies) of citizenship? ____

Please circle your primary areas of expertise and list your specialty areas:

Geosciences ____

Geotechnical ____

Lifelines____

Engineered Buildings ____

Industrial Facilities ____

Architectural and Urban Planning _______________________________________

Social Science ____

Emergency Response ____

Bridges ____

Dams, Harbors, etc ____

Other ____

Please indicate languages other than English in which you are able to communicate:

______________________ ______________________ ______________________

Please list the geographic areas in the U.S. about which you are particularly knowledgeable and especially those in which you have personal contacts:

______________________ ______________________ ______________________

Please list the countries outside the U.S. about which you are particularly knowledgeable and especially those in which you have personal contacts:

______________________ ______________________ ______________________

______________________ ______________________ ______________________

Please indicate the nature of your experience with the above areas and country(ies).

Please indicate previous reconnaissance team experience – earthquake and sponsoring organization:

Please indicate your availability to travel to the following areas:

California _________ contiguous U.S. _________ U.S. including Alaska & Hawaii _________

foreign countries _________ If there are countries you would not be willing to enter, please note:

Please discuss any physical conditions or disabilities that should be taken into account.

What primary issue(s) or problem(s) would you like to gain further information about through field investigation? Please note briefly below:

Reconnaissance Team Member Application page 2

What kind of equipment could you bring to the field (e.g., laptop, 35 mm camera, digital camera, digital video, PDA (e.g. palm pilot), GPS unit, Brunton compass):

Do you have access to a total station instrument for surveying?: ___________________________________

Please indicate to what extent you or your company would be willing to cover your own expenses.

Do you have current inoculations, or will you obtain those that are necessary before traveling to countries outside the U.S. as a member of an EERI Reconnaissance Team:

Yes _________ No _________

Does your medical insurance provide coverage throughout the U.S. as well as in other countries?

Yes _________ No _________ If you answered no, please provide information on its limitations:

NSF requires that your medical insurance include coverage for medical evacuation back to the U.S. should an emergency occur outside the U.S. Does your insurance include this coverage? (this coverage is often issued by credit card companies, as a benefit of membership. Please check your credit card benefits.)

Yes _________ No _________ Not Sure _________

Please return this form, along with your current curriculum vitae, the names and contact information for three referees, to the Earthquake Engineering Research Institute, 499 Fourteenth Street Suite 320, Oakland, CA 94612, or fax it to: (510) 451-5411. If you are a student, please send your curriculum vitae and a letter of recommendation from your faculty advisor.

Appendix M Data Set Terms Definitions

This appendix lists and describes the data sets used in Tables 10 and 12 of the report.

Data Set Name	Data Set Description
Historical hazard information	Information about damage historically created by a certain hazard intensity level
Current hazard information	Current intensity and other characteristics of the hazard
Hazard impact area extents	The spatial extent of the area damaged by the disaster
Location and attributes of buildings and property	The location of buildings and/or property. Their size, elevation, first floor elevation, occupancy type (residential, etc.) and building type.
Level of damage to structures	Structure location, level of damage, damage type, damage location
Transportation network location and attributes	Spatial location and attributes (type, year built, etc.) of roads, bridges, transit systems, rail, ports, and airports
Status of transportation network	Information about closures or restricted operations
Critical business locations	Spatial location, business name, type, size, and owner contact information
Interruption to business and agriculture	Information about which business and agricultural operations are closed or under restricted operations
Medical care locations and regular capacity	Spatial location, treatment capabilities, and regular bed capacity of medical facilities
Senior center locations	Spatial location, center name, type, number of patients, and contact information
School locations	Spatial location, school name, type, number of students, building type, elevation and contact information
High potential loss facilities locations	Spatial location and attributes (type, year built, capabilities, etc.) of dams, levees, military institutions, nuclear power facilities, and hazardous materials facilities
Attributes and location of power service	Spatial location and attributes (size, capability, owner) of electric power network components, power plants, and substations
Status of power service	Information about extent of service area that has no power or restricted service
Location and availability of backup power	What locations and buildings have backup power, how much, and whether power can be diverted to other uses
Oil/natural gas pipelines location and attributes	Spatial location and attributes (size, capability, owner) of oil and natural gas pipelines, refineries, pumping plants, tank farms, and other system components
Location and attributes of water/sewer system	Spatial location and attributes (size, capability, owner) of potable water and wastewater pipes, control stations, tanks, wells, and treatment plants
Status of water/sewer system	Information about extent of service area that has no water/wastewater service or restricted service
Attributes and location of telecommunications	Spatial location and attributes (size, capability, owner, type) of telecommunications lines, stations, and broadcast facilities

Data Set Name	Data Set Description
Status of telecommunications	Information about extent of service area that has no telecommunications service or restricted service
Demographics	Population breakdown by race, ethnicity, age, gender, home ownership status, and income aggregated in small block groups/neighborhoods
Density	Number of persons per square area
Location and attributes of special needs population	Spatial location and attributes (medical condition, type of care needed, age) of special needs individuals
Seasonal, school, and prison population	Number of students, tourists, farm laborers, and prison inmates aggregated by neighborhood or town
Size of exposed population	Number of people exposed to the hazard
Size of evacuated population	Number of people evacuated from and area, how, and to where
Shelter population	Number of adults, children, elderly, and pets per shelter
Cultural population and their cultural needs	Number of people in a certain cultural group and their culture-specific needs in times of disaster
Number, type, and location of injuries and deaths	Number and attributes of those injured (type of injury) and death (cause of death)
Animals impacted	Number and location of animals killed, injured, displaced, or abandoned
Location and abilities of special teams	Spatial location ,response skills and capabilities, and size of special teams
Fire and police station locations and attributes	Spatial location, capabilities, number of trucks/cars, staff size, and contact information
Location of shelters and capacity	Spatial location, contact information, capabilities, and number of beds
Transportation available to shelter	Type and size of transportation, location of transportation, owner, current availability
Food/goods available for response, shelters	Availability, quantity, owner, and location of food and supplies for response efforts
Volunteer availability	Volunteer availability, skills, experience, and contact information
Evacuation plans	Evacuation routes, procedures, and regional assignments
Pre-event plans / IMS procedures	Information about existing disaster response plans and typical emergency response IMS procedures
Availability of health facilities, number of beds	Availability (open, restricted, closed) of health facilities, staffing, number of beds currently available for patients

Appendix N Four Areas Model from Workshop Participant Comments Only

This appendix contains the four areas model generated from the workshop participants' comments only, without any additional input from the authors.

Data Areas and Associated Data Set		DISASTER TYPE Wind	Ice Storm	Flood	Explosion
HAZARD	Historical weather and damage data	X	X		
	Current weather data and conditions	X	X		
	Hazard impact area extents		X		
	Flood water level and location			X	
	Type of explosive and size				X
	Locations and characteristics of target				X
INFRASTRUCTURE	Location and attributes of buildings and property	X		X	X
	Transportation network location and attributes	X		X	X
	Critical business locations	X			
	Hospital locations	X			
	Senior center locations	X			
	School locations	X			
	Agricultural operations location	X			
	Level of damage to structures	X			X
	Status of transportation network	X	X	X	X
	Final structural damage survey	X			
	Interruption to business and agriculture	X		X	
	Changes to built landscape	X			
	Status of power service		X	X	X
	Location and availability of backup power		X	X	X
	Historical power outage data		X		
	Snow removal plans		X		
	Airport Status and Closures		X		
	Location and attributes of water/sewer system			X	X
	Status of water/sewer system			X	X
	Attributes and Location of Power Service				X
	Attributes and location of telecommunications				X
	Status of telecommunications				X
POPULATION	Demographics	X	X	X	
	Density	X			
	Location and attributes of special needs population	X	X	X	
	Seasonal, school, and prison population	X		X	
	Size of exposed population	X		X	
	Size of evacuated population	X			X
	Shelter population	X	X		
	Cultural population and their cultural needs		X	X	
	Number, type, and location of injuries and deaths		X	X	X
	Animals impacted			X	
RESPONSE RESOURCES	Evacuation plan	X			X
	Evacuation route status	X			
	Location and abilities of special teams		X	X	X
	Location of shelters and capacity		X		X
	Transportation available to shelter		X		
	Food/goods available for response, shelters		X		X
	Volunteer availability		X		X
	Pre-event plans				X
	Availability of health facilities, number of beds				X

Appendix O Data Sets Needed in DMSs from Literature Review

This appendix contains the data areas and associated data sets needed by the DMSs assembled from the literature review in this report. Of the DMSs discussed in this report, HAZUS-MH had the most comprehensive data needs information, which is contained in Appendix A. The data needs for the other DMSs were more general and were included in the exhaustive HAZUS-MH required data sets. The only data need that was included in the other DMSs and not in HAZUS-MH was the need for an incident management system to be developed and made operational.

HAZUS-MH data sets were included in Appendix O if they were needed in two out of the three disasters modeled by HAZUS-MH (earthquake, flood, and hurricane) as shown in Table Set 1 of Appendix A. The data set *location and availability of backup power* does not appear in Table Set 1 of Appendix A as a HAZUS-MH data set, but through inspection of Table Set 2 in Appendix A, most infrastructure data sets included the availability of backup power in their data fields.

The data sets are assigned to either inventory or status designations based on whether the data set can be populated prior to a disaster or during a disaster, respectively.

Data Areas and Associated Data Set		Inventory	Status
INFRASTRUCTURE	Location and attributes of buildings and property	X	
	Transportation network location and attributes	X	
	Medical care locations and regular capacity	X	
	School locations	X	
	High potential loss facilities locations	X	
	Attributes and location of power service	X	
	Location and availability of backup power	X	
	Oil/natural gas pipelines location and attributes	X	
	Location and attributes of water/sewer system	X	
	Attributes and location of telecommunications	X	
POPULATION	Demographics	X	
RESPONSE RESOURCES	Fire and police station locations and attributes	X	
	Location of shelters and capacity	X	
	Pre-event plans / IMS procedures	X	