Integration of Information Systems for Post Earthquake Research Response

Norman C. Hester
Association of CUSEC State Geologists
nhester@cusec.org

Jim Wilkinson
Central United States Earthquake Consortium
jwilkinson@cusec.org

Stephen Patrick Horton
Center For Earthquake Research and Information, Univ. of Memphis
shorton@memphis.edu

Theresa I. Jefferson
Institute for Crisis, Disaster and Risk Management, GWU
tjeff@gwu.edu

ABSTRACT

Natural disasters occur infrequently, limiting our ability to develop an inclusive knowledge base concerning such events. The ability to study, interpret, and document findings immediately following a damaging seismic event, is a critical step in furthering our understanding of events, allowing for effective awareness, mitigation, response, and recovery efforts. In the central United States, a Post Earthquake Technical Information Clearinghouse (PETIC) Plan has been developed to coordinate research activities, and to facilitate collaboration between the emergency management and research communities. Because a damaging earthquake in the central U.S. will impact several states, a Multi-State Technical Information Clearinghouse (MSTIC) Coordination Plan to link state technical information clearinghouses (STICs) is proposed. This paper describes beginning efforts to define the role and functions of a MSTIC as well as formalize plans with emergency management agencies to facilitate collaboration and coordination between STICs, the MSTIC.

Keywords

Earthquakes, Technical Information Clearinghouses, New Madrid Seismic Zone

INTRODUCTION

Natural disasters, especially those resulting in extensive damage and loss, generate a strong interest from professionals in the scientific community who desire to research the event. Following the occurrence of natural disasters, such as floods, hurricanes and earthquakes, there is a critical need to be able to share data to, from and between numerous types of researchers and other response organizations.

After an earthquake, engineers, geologists, seismologists, geophysicists and social scientists will attempt to document ground failure, structural damage, and monitor aftershocks, as well as obtain eyewitness observations from those directly affected. These researchers benefit from having a single point of contact or staging area to register; receive information, find various types of support and share their findings. This physical facility, located as close as reasonable to the damaged area is designated as a Post Earthquake Technical Information Clearinghouse (PETIC). A PETIC also has an information system component which is designed to support the researchers and allow them to share their findings. Its is to allow for a methodical investigation of earthquake impacts, facilitate the collection of perishable data, track field investigations, document findings and observations, and provide GIS capabilities for standardized information dissemination. A clearinghouse must be able to: collect, verify, and disseminate perishable data , provide updated damage information to all investigators, monitor the locations of investigators, and assign researchers and other professionals to specific damaged areas based on their expertise.

The primary mission of the PETIC is to gather “information, maximize its availability, and better use the talents of those present” (U.S. Geological Survey, 2003). USGS[1] Circular 1242, “The Plan to Coordinate NEHRP[2] Post-Earthquake Investigations,” outlines an approach to coordinate post-earthquake data-gathering, field studies and analyses, and share the results. It calls for the establishment of post-earthquake technical information clearinghouses within a day following a significant earthquake. Specifically the plan states “Within 24 hours following mutual consultation, the USGS, FEMA[3], and EERI[4] will work with state geological surveys from the impacted states to organize a field technical clearinghouse. Depending on ability and capability, the affected state(s) may take the lead in organizing the clearinghouse..”

As conceived in USGS Circular 1242, the primary role of the clearinghouse, is to facilitate the collection of perishable earthquake data, is a reconnaissance activity performed over a limited time period (approximately six weeks) shortly following the earthquake. The next section of the paper provides several examples of how clearinghouses have been successful in earthquakes and other natural disasters. With Hurricane Katrina, the scope of clearinghouse activities and the duration of their operation have greatly increased. In addition to traditional roles, modern clearinghouses seek to contribute to response and recovery by providing essential information to local, state and federal emergency management agencies. While the nature of the disaster will dictate the type of researchers that are involved, as well as the information, the functions of a technical information clearinghouse remain the same.

The primary earthquake threat in the central U.S. comes from the New Madrid Seismic Zone (NMSZ) which is a 150-mile long fault zone involving eight states - Alabama, Arkansas, Illinois, Indiana, Kentucky, Mississippi, Missouri, and Tennessee. If a significant earthquake were to occur in this region, it is understood that multiple states could establish a state technical information clearinghouse (STIC). To effectively manage and allow for collaboration and coordination among multiple STICs, there is a need for a Multi-State Technical Information Clearinghouse (MSTIC).

This paper provides a conceptual overview of the MSTIC and its role in coordinating and collaborating among and between STICs. The STICs will serve as the major collectors of research data. The goal of the MSTIC is to monitor the operation of the STICs and facilitate the sharing of their research and analysis with others within the research community as well as enhance post-earthquake response, recovery and mitigation efforts by emergency management.

Natural disasters are often categorized as notice (such as hurricanes) or no-notice events (such as earthquakes). With a notice event, there is the ability to predict with some degree of accuracy both the intensity and location of the disaster. This can allow for the pre-establishment and coordination of a clearinghouse. The same is not true for no-notice events. That is why it is important to establish a plan of action in regions which are known to be pre-disposed to the occurrence of events such as earthquakes.

TECHNICAL INFORMATION CLEARINGHOUSES

History

The first large-scale operation of a post-earthquake technical information clearinghouse was following the Northridge earthquake (1994). It served as an information exchange among “practitioners, researchers, emergency managers, and investigators from other states and countries” (Nathe, 1997). The clearinghouse utilized geographical information systems (GIS) technology to collate, analyze and synthesize the collected data. The internet was the main source of data and information dissemination (USGS, 1996).

The clearinghouse established after the Nisqually earthquake (2001) expanded the role of the internet and e-mail for sharing and disseminating information. This clearinghouse website (http://www.ce.washington.edu/~nisqually/index.html), still available to visitors, was the first post-earthquake clearinghouse to remain operational more than five months after an event. In contrast the Northridge Earthquake

[1] USGS – U.S. Geological Survey

[2] NEHRP - National Earthquake Hazards Reduction Program

[3] FEMA – Federal Emergency Management Agency

[4] EERI - Earthquake Engineering Research Institute

Clearinghouse was only operational for 14 days. This represented a fundamental shift in the role of post-disaster clearinghouses, from collecting perishable data in a relatively short time period following an event, to compiling, disseminating, and archiving data for the use of research, modeling, and engineering applications (CSSC, 2001).

Both of the aforementioned clearinghouses were small when compared to the Hurricane Katrina-Rita Clearinghouse (2005) that was established two days after Hurricane Katrina. At the request of FEMA, Louisiana State University (LSU) developed a GIS clearinghouse cooperative, with the goal of providing a permanent, archive of consistent, comprehensive, geospatial data. The Hurricane Katrina-Rita Clearinghouse Cooperative website (http://katrina.lsu.edu/) is a public forum and is supplemented by the Atlas website (http://atlas.lsu.edu) to allow interactive data downloads. Approved users (emergency management and research communities) are able to utilize the GIS for storing and retrieving geospatial data. There is also an imagery database management system, for users at the LSU campus, to access, view and integrate images into GIS programs. Large data sets were placed in the clearinghouse very quickly, from a variety of sources, with the purpose of supporting the response activity (Pine, 2007).

Both the Nisqually and Katrina-Rita Clearinghouses were significant in the evolution of technical information clearinghouses for two main reasons. First, the shift from temporary information sources to serving as permanent information repositories. Second, they focused on increasing utilization of the internet to provide open access to information.

Functions

There are four issues involving data that need to be resolved when developing a technical information clearinghouse. They include: data collection and verification, data organization, data dissemination, and data archival. Figure 1 (adapted from Kong, et al, 2002) illustrates the data input, output and manipulation functions of a clearinghouse. Data needs to be organized so that the information can be stored and retrieved quickly and efficiently. For this to happen there needs to be adequate metadata, file and folder naming conventions, appropriate documentation, etc. It is important to implement a structure that will facilitate the use, storage and retrieval of extremely large data sets. Data dissemination must allow different levels of data access, to protect sensitive information. Providing tools that allow users to view geospatial data as well as integrate it with other GIS programs. It may also be useful to have a different system, as in the Hurricane Katrina-Rita Clearinghouse, utilized by the general public, than that which is being used by authorized users. The ability to archive data is the key to facilitating future research. Data archival methods need to consider how data will be utilized in the future.

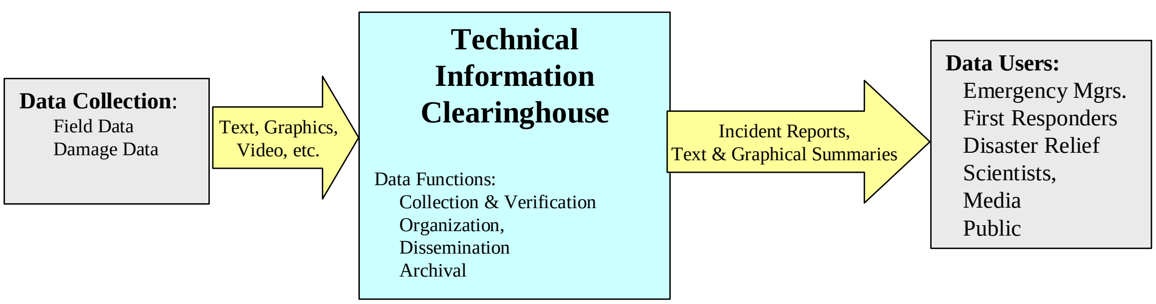

Figure 1. Data Flow in a Technical Information Clearinghouse

MULTI-STATE TECHNICAL INFORMATION CLEARINGHOUSE

Due to the size and location of the NMSZ, a major earthquake will impact up to eight states, each of which could establish an STIC. A damaging earthquake in the central US will affect multiple states each with their own set of governmental laws and policies. This necessitates the need for individual state clearinghouses which serve as a base of operations for field research. A point of coordination is necessary to collect and disseminate information from a central source. This structure follows the methodology used by the emergency management community in their catastrophic planning for an earthquake in the NMSZ. In order to coordinate the efforts of these clearinghouses and allow for collaboration between clearinghouses, an MSTIC would be established. The MSTIC would perform all of the functions of a typical clearinghouse as well as facilitate collaboration and coordination among as many as eight STICs. The individual State Geological Surveys are responsible for maintaining the associated STIC, while the MSTIC is the responsibility of USGS. Figure 2 shows the data flows for the MSTIC.

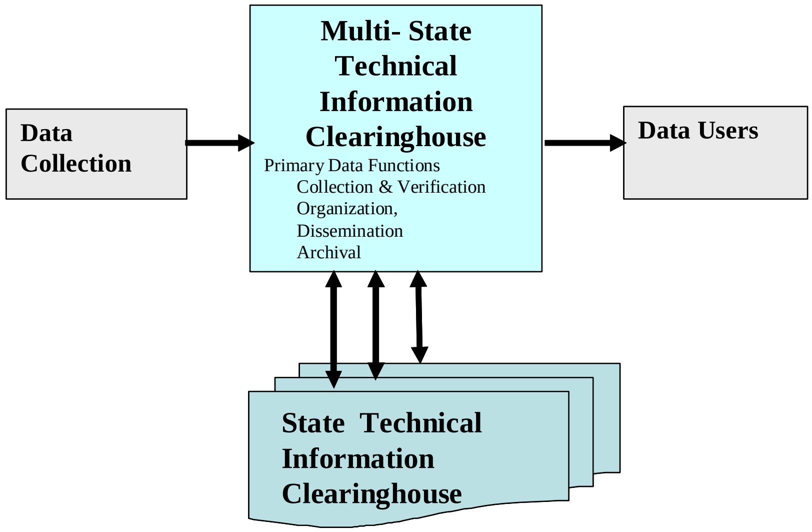

Figure 2. Data Flow in a Multi-State Technical Information Clearinghouse

NEHRP has designated the creation and maintenance of a repository of important post-earthquake reconnaissance data as one of its Strategic Priorities. The goal is to develop and implement a Post-earthquake Information Management System (PIMS). The objective is to identify both infrastructure requirements (e.g., data system architecture, technological needs and issues) and implementation requirements (e.g., facilities, expertise, policies, and funding) for PIMS. (NEHRP, 2008). PIMS will serve as the backbone for the technical information clearinghouses. It is envisioned that the STICs as well as MSTICs will use PIMS as the means for storing, and transmitting information.

As shown in Figure 2, the primary data functions of the MSTIC are the same as those of the individual STICs. The MSTIC will also perform the following addition functions:

- Collect/verify information from STICs
- Monitor the collection of perishable data throughout the impacted area
- Track the location of STIC field investigators
- Disseminate field observations to emergency management
- Develop detailed maps
- Respond, where possible, to requests for assistance from any STIC
- Coordinate the documentation of information collected from field investigators
- Supplement data needs of the state EOCs and FEMA

FUTURE WORK

In order for the MSTIC to be effective, there are a number of issues that need to be addressed and resolved prior to the occurrence of an event. Using lessons learned from previous clearinghouse projects, this study will attempt to resolve issues concerning clearinghouse hosting and linkage, data collection, data organization and archival, and data dissemination.

Due to the uncertainty associated with earthquakes, it is impossible to determine the exact location of a clearinghouse prior to a damaging event. A clearinghouse requires reliable and robust telecommunications and information systems with ample bandwidth for the electronic information sharing of large data sets. One of the steps in the development of this concept is to partner with universities, colleges, and other organizations, with advanced communications and information systems before an event occurs. This will expedite the site selection process immediately following the seismic event. All candidate host organizations must be able to support the PIMS discussed above.

Specifications for the PIMS are just beginning. Currently the focus is on facilitating data gathering and integration with the STICs. Individual STICs will also utilize PIMS allowing for a consistent method of data organization. The majority of post-event data collection takes place in the field. A goal of this study is to allow for more efficient data collection, through use of geo-referenced personal digital assistance, digital video cameras with GPS capability, and other modern tools. Current efforts are focused on developing a procedure to provide free dissemination of standardized software applications and associated data protocols.

The information provided by the clearinghouse will be utilized by many different types of users in various formats (see Figure 2). The clearinghouse will provide summaries, and reports, as well as web-based GIS tools to select information layers. Users need to be given different levels of access, to protect sensitive data. This project will develop a procedure to effectively disseminate data in a wide variety of formats, as well as pre-authorize user access.

CONCLUSION

The unique multi-state impact created by an earthquake in the central U.S. necessitates the need for a plan that goes beyond current standard clearinghouse plans. This proposes the use of a MSTIC that would enable it to collaborate and coordinate the work of multiple STICs. The results of this effort will be incorporated into a plan for a MSTIC in the NMSZ.

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- Earthquake Engineering Research Institute (EERI)
- Federal Emergency Management Agency (FEMA)
- George Washington University
- US Geological Survey (USGS)

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