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Geographical Information Systems Adaptations for Improved Immediate Damage Assessments

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CERTIFICATION STATEMENT

I hereby certify that this paper constitutes my own product, that where the language of others is set forth, quotation marks so indicate, and that appropriate credit is given where I have used the language, ideas, expression, or writings of another.

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Abstract

Geographical Information Systems can assist in the timely creation of a common operating picture and situational awareness by integrating data collected during the Immediate Damage Assessment (IDA) Process. The problem is that the Holland Department of Public Safety is uncertain whether Geographical Information Systems technology can be effectively used for the collection and documentation of information gathered during damage assessments that occur immediately following an incident. The purpose of this research effort is to determine if Geographical Information Systems technology can improve and enhance the timely collection of information gathered during IDA conducted following an incident. A descriptive research process was conducted to identify (a) if GIS technology is applicable to the immediate damage assessment process, (b) what resources and costs are associated with GIS applications for immediate damage assessments, (c) what training and education is required for responders to implement GIS technologies during the immediate damage assessment process, and (d) how have other organizations incorporated GIS technologies into their own immediate damage assessment procedures? A survey with limited response indicated that (a) many agencies in Michigan utilize GIS, (b) some utilize it for immediate damage assessments, and (c) training and investment in adapting GIS for damage assessments is minimal. Based on the results of the procedures and literature it is identified that GIS is applicable to the damage assessment process and HDPS should (a) identify current capabilities and assess needs, (b) form partnerships with GIS users in the City of Holland, (c) identify and consult with agencies that have successfully incorporated GIS and damage assessment, and (d) conduct additional research on this topic to supplement shortcoming in the data received through the survey procedures utilized.

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Geographical Information Systems Adaptations for Improved Immediate Damage Assessments

Introduction

Immediate damage assessment, or what is commonly referred to as rapid damage assessment, is one of the first key actions that must occur immediately following a serious incident or disaster (McEntire, 2002; Santa Clara County OES, California ARES/RACES, 2007). The information gathered during this process begins to create a picture of the impact to life, critical infrastructure and private properties during the response phase of the incident (Klitz & Smith, 2011; McEntire; Santa Clara County OES, California ARES/RACES). The primary purpose of this information is to coordinate the emergency response which includes identifying resource needs and gathering the status of life sustaining facilities such as health care, electrical generation and water treatment facilities (Klitz & Smith). Secondary to the response, information gathered that identifies damage to public and private properties can assist in facilitating the receipt of federal funds during the recovery phase of the incident (Klitz & Smith; McEntire). These immediate damage assessments (IDA) must occur in a rapid fashion with accuracy and sufficient detail (Santa Clara County OES, California ARES/RACES).

To improve the efficiency and timeliness of the damage assessment process some agencies have employed the use of Geographical Information Systems (GIS) (Short, 2011). GIS can be defined as a tool for the integration of software, hardware and associated data for use and application in a geographical format (Environmental Systems Research Institute [ESRI], n.d.). It allows for the timely solution of problems and answering of questions (ESRI).

Electronic or computer based GIS have been utilized since the early 1960's (Coppock & Rhind, 1991). Manual methods of GIS were employed as early as a century before the 1960's (Coppock & Rhind). Primitive, non-computer based methods, included the use of overlays to indicate the location of troops during the Battle of Yorktown and dot maps that helped locate

Broad Street Pump, which was the source of one of Europe's most significant Cholera outbreaks (Antonia-Brovelli, 2011).

The importance of GIS is that they allow for decision making based upon spatial relationships (Cova, 1999). Cova (1999), indicates that the importance of GIS in the response phase of a significant incident or disaster is that it integrates the available spatial data and disseminates it to the emergency management personnel involved with the incident. Johnson (2011) suggests that the GIS that exist today can provide public safety agencies with the ability to share and exchange information among many viewers and create situational awareness. It is suggested that ongoing use of GIS for the development of a common operating picture has allowed for improved and more coordinated efforts and decision by the public safety agencies (Johnson).

There have been two recent significant tornado events that occurred in 2011 where GIS were employed (Short, 2011). These include Tuscaloosa, AL on April 27, 2011 and Joplin, MO on May 22, 2011. In Tuscaloosa, AL personnel were able to complete many of the components of the damage assessment process in a matter of minutes on a computer terminal (Short).

It is suggested that GIS technologies can improve immediate damage assessment and create an improved situational awareness. The problem is that the Holland Department of Public Safety is uncertain whether Geographical Information Systems technology can be effectively used for the collection and documentation of information gathered during damage assessments that occur immediately following an incident. The purpose of this research effort is to determine if Geographical Information Systems technology can improve and enhance the timely collection of information gathered during IDA conducted following an incident.

The research effort contained herein was created to answer the following questions: (a) is GIS technology applicable to the immediate damage assessment process, (b) what resources and costs are associated with GIS applications for immediate damage assessments, (c) what training and education is required for responders to implement GIS technologies during the immediate damage assessment process, and (d) how have other organizations incorporated GIS technologies into their own immediate damage assessment procedures? The type of research process utilized to complete this applied research project is descriptive.

Background and Significance

The City of Holland is a lakeshore community located in southwest Michigan. The city is situated approximately 2 miles east of Lake Michigan and roughly 20 miles southwest of the City of Grand Rapids. It is a diverse community with 33,051 residents contained within its' approximately 17 square mile borders (United State Census Bureau, n.d.).

Public Safety services are provided to the residents of the city by the Holland Department of Public Safety (HDPS). The nominally consolidated public safety department consists of both the former Holland Police and Fire Departments and was created on July 7, 2010 through formal action of the Holland City Council (Perales, 2010). At this time the department maintains separate police and fire functions under the direction of a Chief of Public Safety.

Organized fire protection in the City of Holland dates back to February 8, 1848 when a committee was formed to identify the minimal equipment needs and procedures to keep the city safe from fire (Den Uyl, 2008; Holland Department of Public Safety - Fire Services, 2012). Today, what is referred to as the Fire Services Division of the department, provides code enforcement, public education, fire response, emergency medical services and operations level support to hazardous materials incidents (Holland Department of Public Safety - Fire Services,

2012). In 2011, the branch responded to 2,845 calls for service: 69% or 1,985 of these calls were emergency medical service responses (Holland Department of Public Safety - Fire Services). A July 2009 evaluation of the city's fire protection by the Insurance Services Office established a Protection Class Rating of 4 (Insurance Services Office Incorporated [ISO], 2010).

The fiscal year 2013 operating budget for fire services is approximately $2.7 million (City of Holland [City of Holland], 2012). This provides for the general operations of the branch and funds the current staffing model which includes 6 Lieutenants, 14 full-time Firefighters that are divided over a three platoon system that work a 56 hour workweek and 30 Part-Paid Firefighters (Holland Department of Public Safety - Fire Services, 2012). In addition, the branch has a Captain of Fire Operations, a Fire Marshal and a Department Assistant that are scheduled on a 40 hour work week (Holland Department of Public Safety - Fire Services).

The staffing model noted herein is a factor of significance when considering this research effort. In 2000 the Holland Fire Department had a staffing of 29 full-time personnel and 30 part-paid personnel (Holland Fire Department, 2001). Today this has been reduced to 23 full-time personnel, which is inclusive of 40 hour administrative personnel (Holland Department of Public Safety - Fire Services, 2012). The staffing has continued to be reduced in an effort to maintain financial stability within the city. These actions are a result of decreased revenue from state revenue sharing and reduced property taxes that are coming to the city (Goodell, 2011; City of Holland, 2012). This scenario has provided motivation and incentive to become more efficient with the personnel we have and the resources available. This research effort will assist in determining if GIS will provide efficiency to a limited workforce when conducting an important component of their job.

A second factor that is significant when considering the scope of this research effort is that HDPS does not have a standard operating guideline or policy for conducting damage assessment. It was clearly identified by Szakacs (2009) that the Holland Fire Department did not have a damage assessment plan. It was noted at that time that the department was challenged with limited staffing and equipment and would have difficulty in conducting damage assessments in a rapid manner (Szakacs). A recommendation and suggested procedure for the department were developed by Szakacs (2009) however these have not been implemented. The research effort by this researcher with consideration of the efforts by Szakacs may provide a comprehensive and efficient damage assessment process that may be further enhanced by implementation of GIS technologies where appropriate.

The third consideration with regard to this research effort is that fact that the City of Holland is not immune to significant incidents where damage assessment is required. On July 11, 2011 Holland suffered a straight line wind event where pockets of the city suffered severe damage (Schieber, 2011). On June 19, 2009 the city encountered significant rain and as a result suffered significant areal flooding which resulted in considerable damage to public and private property as well as infrastructure (Goodell, 2010). The researcher has been unable to locate any evidence of an organized immediate damage assessment during this event however was able to identify some public discontent with the way the event was handled. A letter to the editor shortly following this event appears to indicate that no immediate damage assessment was conducted (Chavez, 2009).

A final consideration regarding this research effort is that the City of Holland and The Holland Board of Public Works (HBPW) has already invested approximately $1 million over the last 24 years in GIS for the city and HBPW (M. Van Dyken, personal communication, May 30,

2012). The system brought into existence by the HBPW and began with the scanning and digitizing data that was in a paper format (M. VanDyken, 2012). This current system includes base maps, aerial photos as well as many layers that are specific to utilities and properties.

The City of Holland & HBPW continues to invest in GIS and recently entered into an Environmental System Resources Institute (ESRI) site license agreement to offer this technology to both entities. The total cost for this agreement is approximately $10,000 and $25,000 for the City of Holland and HBPW respectively (M. VanDyken, 2012). This significant investment in technology has created the backbone and framework for a potential GIS based damage assessment program.

When considering: (a) the need for efficiency due to reduced staffing, (b) the need for a standard operating guideline for immediate damage assessment, (c) the fact that significant incidents and disasters do occur in Holland, and (d) that a significant investment has already been made in GIS technology for the City of Holland, this research effort is a logical exercise to determine if GIS technology can improve IDA in the City of Holland. By completing this research and acting on subsequent recommendation it is the belief of the researcher that there is a potential to improve one of the primary incident objectives that is identified during significant incidents; this objective being the completion of an immediate damage assessment that provides situational awareness and a common operating picture (Johnson, 2011).

This applied research project (ARP) is directly related to the *Executive Analysis of Fire Service Operations in Emergency Management* (EAFSOEM) course objectives outlined in Chapter 4 of the student manual (Federal Emergency Management Agency [FEMA], 2011). One of these enabling objectives is to, “Develop a process for obtaining and using damage assessment information” (FEMA, p. 4-1). The research of GIS applications in this ARP may allow for the

development of an improved process for obtaining damage assessment information and may furthermore create additional opportunities for using the information collected.

In addition to the relationship to course objectives this ARP assists in supporting goals established by the United States Fire Administration (USFA) in the 2010-2014 strategic plan. This ARP relates and supports the goal to, "Improve local planning and preparedness" (United States Fire Administration [USFA], 2010, p. 14). One of the operational initiatives included with this goal is to incorporate GIS modules for inclusion into National Fire Academy (NFA) modules (USFA, p. 19). In addition, this ARP correlates with the USFA goal to, "Improve the fire and emergency services' capability for response to and recovery from all hazards" (USFA, p. 14). The objectives associated with this goal refer to the improving decision making skills that are needed during an incident. GIS technologies adapted to damage assessment processes may work in collaboration with skills that are improved through the efforts of the USFA and NFA.

Literature Review

To provide a framework and context for this applied research project (ARP) a literature review was conducted. This began with an internet search utilizing, Google, Google Scholar and Yahoo to identify various forms of media that have significant relevance to the research problem. In addition to the internet inquiry, contact was made with the Learning Resource Center (LRC) on the campus of the National Emergency Training Center (NETC) located in Emmitsburg, MD. As with previous ARPs the LRC was instrumental in assisting and providing instruction to the researcher for searching the online card catalogue. Mr. Bernie Mulhern, a librarian at the LRC, was able to provide the researcher with a listing of bibliographies that assisted in narrowing the search for information that is specific to the topic of this research effort (B. Mulhern, personal communication, October 24, 2011).

To facilitate further review of the literature, the researcher made contact with staff at the Van Wylen Library which is located on the campus of Hope College in Holland, MI. The ability to utilize online services such as the Gale databases was instrumental to being able to complete a sufficient search of literature that the researcher would have difficulty accessing in other ways.

The literature review focuses on four specific areas related to the problem statement. These include (a) the applicability of GIS to IDA , (b) the resources and costs associated with GIS and applications for IDA, (c) training and education requirements to utilize GIS for IAD, and (c) how organizations incorporate GIS into their IDA.

The EAFSOEM Student Manual defines immediate damage assessments and preliminary damage assessments as two separate but related processes (FEMA, 2011, chap. 4). Klitz & Smith (2011) discuss damage assessment as more of a process than that begins with (a) the focus on gathering immediate damage assessment information to create the common operating picture of the event for an effective response, (b) identifying damage to critical infrastructure, (c) gaining information on the damage to public, private and commercial property to facilitate federal funds for recovery, and (d) to deploy search and rescue teams in a timely and organized manner. The literature often identified the damage assessment as rapid, immediate or simply as damage assessment. Regardless of how the process was identified it is apparent that GIS technology has universal applicability to damage assessment and therefore the researcher did not limit literature that was specific to IDA.

The Applicability of GIS to Immediate Damage Assessments

As noted in the introduction GIS provides a framework for the linking of various forms of data for placement into a geographic format (ESRI, n.d.). Utilizing these tools assists in providing a common operating picture and situational awareness for those involved with an

incident or event (Johnson, 2011). The literature suggests a number of applications for GIS from tracking the epidemiology of a virus outbreak to the rebuilding of a war torn country.

Lebenow and Tolson (2001) identified a process where demographic information including income levels was utilized to create a geographical picture of where groups at high risk for developing breast cancer could be located. Alameda County,CA utilized this information to develop an outreach program targeted specifically to the high risk groups and significantly raised early detection activities by affected populations (Lubenow & Tolson, 2001).

GIS have also been utilized to track the spread of acute disease. In 2002 and 2003 investigators in Hong Kong analyzed data about patients that had severe acute respiratory syndrome (SARS) and plotted their addresses using GIS to identify how the disease was spreading during large outbreaks (Alderson, 2004). Their analysis of the GIS was utilized to identify large outbreaks, study the significance of geographical areas and study the relationship between geographical locations and the spread of the outbreak (Alderson).

Further use of GIS technology has assisted with the rebuilding of Lebanon following a war that occurred there in 2006 (El Sayed, 2007). Following this event damage assessment incorporating GIS was utilized to plan and coordinate the reconstruction of the country (El Sayed). It was identified that GIS can be used to (a) consolidate data for the construction of maps, (b) coordinate geographic and non-geographic information for study and analysis, (c) assist with dissemination of information to all personnel involved with the incident or event, and (d) coordinate recovery activities such as reconstruction (El Sayed).

In the realm of emergency management Cova (1999), suggests that GIS play a role in all segments of the emergency management process. Cova (1999) chose to consider the use of GIS in the context of "…mitigation, preparedness, response and recovery…" (p. 846). This is

consistent with Johnson (2000) who indicates that GIS provides a platform or foundation for the emergency management process that is inclusive of planning, mitigation, preparedness, response and recovery. With regard to use of GIS by first responder agencies for preparedness it is noted that the Wilson, NC fire department is utilizing this technology for the development of pre-incident planning and ongoing risk assessment (Oliver, 2011). This information is later used during the responses to assist in providing information that is needed to make key decisions that promote a safer working environment for fire personnel and the community (Oliver).

In the context of the emergency management process, immediate damage assessment plays an important role in the recovery phase which is a difficult task to accomplish during a disaster (Johnson, 2000). GIS in concert with data from global positioning systems (GPS) and advanced vehicle locating (AVL) can be utilized to provide real time data to everyone involved in the response and recover phases of an incident.

The literature strongly suggests GIS, regardless of the applications provide the potential for integrating data in a number of different formats, provides the ability to share information among others in a timely manner and furthermore provides a common operating picture and situational awareness to all of those involved with a particular event (Johnson, 2011). With consideration of these items it is apparent that utilizing GIS as a tool for damage assessment is appropriate and could be considered integral to improving the success of immediate damage assessments.

Resources and Costs Associated with GIS Applications for IDA

To implement GIS technologies into the damage assessment process requires the availability to obtain software and hardware and the means to purchase and maintain it. In a fundamental form GIS could be as simple as a map with dots. Antonia-Brovelli (2011) identifies

that the early concept of GIS utilized simple base maps with overlays. This included overlays to track troop movements during the Battle of Yorktown and dots placed on a map that was utilized to track the cholera outbreak in England to the Broad Street pump (Antonia-Brovelli). Simple, low cost technology; however, it was an effect method for correlating available data with geographical locations to create observable relationships that could result in situational awareness.

Today technological advances have improved the ability to study geospatial relationships that can be used to effectively manage response and recovery efforts. The use of personal cell phones with GPS capability combined with coordinated digital photos transmitted by email have been utilized with success (Klitz & Smith, 2011). Patterson (n.d.) noted that damage assessment conducted during a wildfire required teams to have mobile software for GIS, handheld computers, GPS receivers and the ability to take digital photos and videos. These tools were for the collection of data and did not include other software and base maps needed to correlate data once obtained. Further advances include the development of IDA software referred to as "The Windshield Assessment Survey software (Geocove 12C software)…" (McKenna, 2010, ¶ 4). This particular type of software was utilized during the damage assessments conducted in Lee County, Fl following Hurricane Charley in 2004 (McKenna). It is noted that costs for this software which was developed by ESRI are based upon the population of the jurisdiction utilizing it (McKenna). There was no information identifying the cost per capita.

Other software available from ESRI includes a program called Public Safety Damage Assessment for ArcGIS 10 (Environmental Systems Research Institute [ESRI], n.d.). This is identified as a mobile tool that can be used with ease for use in the field with mobile technology (ESRI). To obtain costs it is necessary to contact an ESRI representative.

The literature does not appear to provide a significant amount of information regarding costs. From the review it is noted that the equipment and software can be separated into two categories. The first being GIS or the backbone which provides the known geographical context and the second category being the software and adjuncts needed to gather and assimilate data for placement into GIS or geographical framework. In consideration of this, costs will vary from jurisdiction to jurisdiction. In Franklin County AL, the county engineer stated that the $170,000 investment in GIS was justified after the value of the system was demonstrated after the county was impacted by the same storm that spawned tornados in Tuscaloosa AL in 2008 (Short, 2011). Contrast this with the approximately $1 million over the last 24 years invested by the City of Holland and HBPW (M. VanDyken, 2012).

Variations in the investment by jurisdictions will vary based on needs and size of the community. The City of Holland and the HBPW have already made a significant investment in GIS. To implement applications in the City of Holland GIS for IDA would require some additional software costs however most of the equipment needed to conduct the exercise is currently available and in use.

Training and Education for Those Utilizing GIS for IDA

Training in the use of equipment and software needed to incorporate IDA with GIS appears to vary. In what appears to be an extreme case McDowell & Moore (2002) state that training personnel in the basics took two days. This training was comprehensive and included training on GIS as well as what teams needed to know when they are in the field gathering information with PDA or laptop computers (McDowell & Moore). In a second instance it is observed that the New York State Department of Transportation (NYSDOT) was able to prepare teams, with little or no experience with their software or hardware, to go into the field and

conduct damage assessment with as little as 5-10 minutes of training and instruction. In a final example it is noted that CERT teams involved with an exercise conducted by Texas A&M University, received in service training or what was referred to as “just in time training” (Klitz & Smith, 2011, p. 2).

With regard to training requirements, these appear to vary depending on the assigned task in the damage assessment process. It is noted that GIS operators will need to have more training than the damage assessment teams in the field. With time being of the essence in the IDA it is important to note that damage assessment could be up and running in a rapid fashion with little instruction and direction. This opens up possibilities when considering staffing needs and who can conduct the damage assessment.

Incorporation of GIS Into IDA

There are numerous jurisdictions that have incorporated GIS in to the IDA process. The research suggests that the use of GIS in conjunction with IDA crosses disciplines. As noted previously NYSDOT incorporated GIS into their damage assessment programs (Road Status and Damage Assessment Tool, 2010). In 2007 NYSDOT began to utilize a program developed by ESRI called Road Status/Damage Assessment (RSDA) which is a field tool that can use GIS coordinates (Road Status and Damage Assessment Tool).

In Tuscaloosa AL, the use of GIS, GPS and other wireless adjuncts played a major role with the recovery efforts that took place after a string of tornadoes damaged the area (“GIS GPS and Wireless“, 2011). Personnel conducting damage assessments utilized an application developed by Geocove Incorporated called ARM360 (“GIS GPS and Wireless“). It is noted that ARM360 provided an up to date operating picture from mobile devices that included laptops, tablets and other mobile devices (“GIS GPS and Wireless“).

Although it was not clearly utilized for the immediate damage assessment process, GIS was utilized in the damage assessment for reconstruction efforts that were required in the City of New Orleans following Hurricane Katrina (Hampton & Webb, 2005). It appears that the focus of the GIS in New Orleans was to produce maps that primarily illustrated property information such as zoning and land use (Hampton & Webb).

A final example of GIS implementation occurred in Fenton, Michigan on August 25, 2007 (City of Fenton Michigan, 2009). It was on this date that the city was impacted by an EF2 tornado (City of Fenton Michigan). Although data collection was manual in nature, personnel were able to bring that data to a centralized location for incorporation into the city's GIS and real time updates were made through the use of applications called ArcView and ArcEditor (City of Fenton Michigan). It is noted that the City of Fenton had developed scenarios based on potential tornado paths prior to this event which allowed for immediate coordination of a response to affected areas of the city (City of Fenton Michigan).

In summary, it appears that the review of literature relative to this research effort indicates that GIS is applicable to the damage assessment process. This is regardless of what phase suggests that GIS is valuable to all phases of the emergency management process (Cova, 1999). Second it is noted that equipment needs and costs vary based on the community and what they currently have available to them as far as GIS technology. If GIS already exists in a community the investment for equipment needed to incorporate data collection for damage assessment may be relatively small compared building the GIS platform. In Fenton, Michigan it appears that the IDA process was done manually and updated at the EOC by GIS operators (City of Fenton Michigan, 2009). This could be conducted in a manner that would not require a large investment in equipment.

With regard to training is it suggested that this varies based upon the tasks that personnel are required to accomplish during the damage assessment process. Personnel directly involved with the GIS may be required to undergo days of training (McDowell & Moore, 2002). Others assigned as field teams conducting assessments may be fully functional with little or no training at all (Road Status and Damage Assessment Tool, 2010).

Finally, there are a number of examples where jurisdictions have successfully implemented GIS as part of their damage assessment programs. From tornados in Alabama to hurricanes in Louisiana the use of GIS has been instrumental in the response and recovery phases of emergencies ("GIS GPS and Wireless", 2011; Hampton & Webb, 2005; Short, 2011).

Procedures

The procedures for this research effort consisted of a survey of west Michigan jurisdictions near the City of Holland, a group of fire service professional from the National Fire Academy and a GIS users group. The remainder of this section will identify (a) the purpose of the survey, (b) the development of the survey, (c) the populations and the total number of respondents, and (d) the limitations of the procedures.

Purpose of Survey

The purpose of the survey was to obtain data that identifies other cities and jurisdictions in west Michigan that utilize GIS but also do so for immediate damage assessments. Additional information to be gathered from the survey included the hardware and software requirements, associated costs, training requirements and user sentiment towards this form of technology as it is used to conduct immediate damage assessments.

Development of Survey

Development of the survey was conducted utilizing an online survey service called SurveyMonkey (SurveyMonkey, n.d.). This service allowed adequate flexibility for the groups being surveyed. To allow for better reporting features the researcher upgraded from the free version of the service to the Select plan. This plan allows the user to export reports in both Excel and Portable Document Formats (PDF) (SurveyMonkey).

Once developed, distribution was accomplished by pasting a web link into a formal letter emailed to members of the three groups surveyed (see Appendices A and B). To keep data organized and unique to each group surveyed, separate surveys were created each with their own link.

As for the creation of the survey questions, there were 10 created to obtain information necessary to answer the research questions developed for this ARP (see Appendix C). Seven of these questions were multiple choice and the remaining three allowed respondents to provide written comments to obtain information regarding hardware and software needed to IDA that utilize GIS, training hour requirements and opinions regarding how receptive members of each individual organization were to the use of GIS for IDA.

Questions 2 and 10 of the survey were directed at gathering addition information about the organizations surveyed for future use by the researcher should GIS be utilized for damage assessment in the City of Holland. Survey question 10 was designed to identify potential human challenges that exist with the implementation of new technology and procedures. Where comments were provided they were recorded and placed in an appendix in this ARP (see Appendices E, G and I).

The appendices separate responses by organization. For clarity each organization will have one appendix that contains full survey results multiple choice questions and a second that contains all of the written responses where questions either allowed for a written response or required one. As an example the multiple choice responses from the Michigan Municipal League are contained in Appendix D. Written responses for options identified as other and for survey questions 5, 7 and 10 can be found in Appendix E. This sequence is typical for the remaining two groups surveyed.

Populations and Respondents

The populations selected for the survey included members of the Michigan Municipal League (MML), EAFSOEM Students and members of a GIS users group called IMAGIN. The MML was selected due to it having a known and defined membership of cities and villages throughout the state of Michigan. To refine the population further, it was determined that the survey should be distributed to members that are in west Michigan. For the purposes of this ARP west Michigan, was defined as an area of the Lower Peninsula that is located west of a boundary created by highway US-27.

With the assistance of Matt Bach and Mary Charles of the MML the survey was distributed to 144 members of the league on November 29, 2011 (M. Bach, personal communication, November 29, 2011). Shortly after the distribution, Bach advised that the email that was sent with the survey had a 31% open rate (M. Bach). Table 1 summarizes the distribution of the surveys to this group and the total number of respondents.

The second group selected for the survey was the EAFSOEM cohorts of the researcher. The purpose of this was to identify what Executive Fire Officer Students are doing with GIS in their own jurisdictions. After completing the EAFSEOM course students would understand the

immediate damage assessment process and may be more knowledgeable about what the GIS capabilities are for their community. The same survey provided to the MML was provided to the EAFSOEM cohorts on December 27, 2011. Table 2 identifies the distribution of the surveys and total number of respondents for the EAFSOEM students.

Table 1

Sample size and total responses for survey provided to MML members

Definition	MML Members
1. Total Population For West Michigan Members	144
2. Required Sample Size for 95% Confidence Level	105
3. Required Sample Size for 20% Non-response Rate	126
4. Total Number of Completed Surveys	19

After the researcher began to monitor return rates on the surveys provided to MML members and EAFSOEM students, it was determined that an additional survey of another defined group was needed due to low response rates in these two groups. To assist with identifying an additional group, Sam Klimoski of ESRI was contacted. He advised the researcher of two GIS users groups in Michigan that may assist in being a part of the survey (S. Klimoski, personal communication, January 10, 2012). IMAGIN and MiCAMP were the two groups suggest by Klimoski and it was suggested that they may be more knowledgeable of the subject and furthermore may provide a better response (S. Klimoski).

Table 2

Sample size and total responses for survey provided to EAFSOEM students

Definition	EAFSOEM Students
1. Total Population of EAFSOEM Students	21
2. Required Sample Size for 95% Confidence Level	19
3. Required Sample Size for 20% Non-response Rate	NA
4. Total Number of Completed Surveys	8

IMAGIN is the acronym for Improving Michigan's Access to Geographic Information Networks. This group is a network of GIS professionals that utilize or interface with spatial resources throughout Michigan (Improving Michigan's Access to Geographic Information Networks [IMAGIN], n.d.). Although not First Responders this defined group of people would be more familiar with GIS and the applications for them.

Table 3

Sample size and total responses for survey provided to IMAGIN Members

Definition	IMAGIN Members
1. Total Population of IMAGIN Members	162
2. Required Sample Size for 95% Confidence Level	114
3. Required Sample Size for 20% Non-response Rate	137
4. Total Number of Completed Surveys	15

The researcher received assistance from Maryellen Jansen of IMAGIN throughout the end of January 2012. After approval of the IMAGIN Executive Committee, Jansen distributed the survey to 163 members of the users group on February 9, 2012 (M. Jansen, personal communication, February 9, 2012).

Table 3 provides information regarding the total population and the total number of respondents for IMAGIN members.

Limitations

One of the primary limitations of the procedure identified in this ARP is the poor response rate that extends across all three populations targeted by the survey. This could be due to a number of factors which include (a) a lack of knowledge about either topic by the respondents, (b) no relationship to the subject by the respondents, (c) spam filters, and (d) email lists and databases that are not up to date. Regardless of the reasons for a low response rate, the information gathered cannot be viewed as confident and reliable.

Survey procedures utilized for previous ARPs conducted by the researcher were directed to only fire department administrators throughout west Michigan. Response rates were low with this population as well and therefore it was determined that directing request to populations outside first responder agencies may increase response rates. In addition, it was the belief of the researcher that an official request from each organization on the behalf of the researcher would add formality and possibly sanction the request. With consideration to this the MML was selected to assist with the distribution of the survey request. This created an additional limitation which was the inability to insure that the request was emailed to the person who could most appropriately provide responses to the survey.

In the case of the MML many of the potential respondents could have been the City Mangers, Village Supervisors and other administrators who may not know or understand the subject of the survey. In addition they may not have forwarded the request on to the person in their organization that could provide the information needed. If this approach is utilized in the future it is imperative that the researcher clearly identify where the survey should be directed. To improve the potential response rate it may be more appropriate for the researcher to request a database from selected populations and contact appropriate personnel directly.

With respect to low response rates, the researcher made contact a second time with Mary Ellen Jansen of the IMAGIN group and requested assistance with sending a second request to the membership. On March 12, 2012, the survey was again sent to all members of the IMAGIN group (M. Jansen, personal communication, March 12, 2012). This request yielded approximately 5 additional responses.

The response rates and results were discussed with Laurie Van Ark and Linda Warner; both are researchers with the Carl Frost Center for Social Science Research at Hope College in Holland, Michigan. Van Ark and Warner agreed with some of the potential reasons for low response rates and indicated that they are challenged with response rates regardless of the research procedures utilized (L. Van Ark & L. Warner, personal communication, May 29, 2012). Further discussion occurred regarding the confidence of the data provided through the survey. Warner suggested that “you work with what you have”, however noted that based on a review of the data and size of the populations the margin of error is in the area of 20% (L. Van Ark & L. Warner, 2012). It was suggested that results are simply suggestive of what may be occurring in this subject area (L. Van Ark & L. Warner, 2012). In summary the data is directional in nature and may be useful in guiding additional research needed on this topic.

A second limitation is the survey itself. The researcher did not craft the survey in a manner that directly answered some of the research questions. An example is research question 4 where the intent of the question is to identify how other groups or agencies have implemented an IDA process that incorporates GIS. The survey does not directly seek out responses for this research question. Based on the survey the only way to answer this question is by reviewing the written responses provided to survey question 5. This question asks respondents to identify what hardware and software was needed to successfully implement GIS technology into the IDA process. Other information can be inferred from survey questions 9 and 10 where respondents were asked to identify how well personnel received the technology and secondly how their respective organizational cultures helped or hindered the implementation. In summary the survey results are not in parallel with the research questions presented in the introduction of this ARP.

The data or results needed to answer research question 4 could have been obtained more effectively through the application of a different type of research procedure. The use of interview procedures with current users of GIS that utilize it for IDA may have answered the question more effectively. Another consideration could be the use of focus groups made up of people from organizations that conduct IDA and utilize GIS.

Results

This ARP employed a descriptive research approach to address the research questions that are being used to determining if GIS technology can improve and enhance the timely collection of information gathered during immediate damage assessments. The survey results contained in this ARP provide limited answers to the research questions however they do provide some information as to what may be occurring in this subject area and help direct further

research that is needed in this area. The following is a listing of survey results and answers to each research question.

Research Question 1 Results

Is GIS technology applicable to immediate damage assessments? To answer this, survey questions 1, 3, and 4 were utilized to determine (a) if respondents conduct IDAs, (b) if the respondents use GIS, and (c) determine if respondents use GIS to assist with IDAs. The survey results for questions 1, 3, and 4 are identified in the following Tables 4, 5 and 6.

Table 4

Survey Question 1: Does your city or village conduct immediate damage assessment following natural or manmade disasters?

Survey Group	Yes (Frequency/Percent)	No (Frequency/Percent)
MML	14/77.8%	4 /22.2%
EAFSOEM	6 /75.0%	2 /25.0%
IMAGIN	12/80.0%	3 /20.0%

As noted previously, the data gathered is not presented with a high degree of confidence however it does appear that most respondents indicate that they do conduct IDA and currently have GIS in their jurisdiction. When asked if respondents utilize their GIS for IDA, some variation was noted. It is understood from the results to questions 1, 3 and 4 that there are groups and organizations that do utilize GIS for conducting IDA. This does appear to indicate that GIS

have applications for damage assessment (see Appendices D, F and H for complete survey results to these questions).

Table 5

Survey Question 3: Do you currently have GIS (Geographical Information Systems) technology in use in your city or village?

Survey Group	Yes (Frequency/Percent)	No (Frequency/Percent)
MML	11/61.1%	7 /38.9%
EAFSOEM	8 /100.0%	0 /0.0%
IMAGIN	15/100.0%	0 /0.0%

Table 6

Survey Question 4: If you answered yes to question #3, do you utilize GIS technology to assist with Immediate Damage Assessments?

Survey Group	Yes (Frequency/Percent)	No (Frequency/Percent)
MML	2/15.4%	11/84.6%
EAFSOEM	4 /50.0%	4 /50.0%
IMAGIN	10/71.4%	4 /28.6%

Research Question 2 Results

What resources and costs are associated with GIS applications for immediate damage assessments? Survey questions 5 and 6 were utilized to determine costs associated with equipment and software needed to conduct IDAs with GIS. Survey question 5 required respondents to identify what hardware and software they utilized to conduct IDA. The results to this question were received as text and are too numerous to include in this section of the ARP therefore presented in Appendices E, G and I. Survey results are contained in Table 7 for survey question 6.

Table 7

Survey Question 6: How much has your city or village invested in adapting GIS technology to enhancing damage assessment practices?

	(Frequency/Percent)			
Survey Group	< $5,000	$5,000 to $10,000	$10,000 to $15,000	Other
MML	5/50.0%	0/0.0%	0/0.0%	5/50.0%
EAFSOEM	2/28.6%	0/0.0%	4/57.1%	1/14.3%
IMAGIN	4/33.3%	1/8.3%	1/8.3%	6/50.0%

Note: To view responses for respondents selecting other, see question 6 in Appendices E, G & I.

A review the data across the survey groups indicates that investments have been made in mobile technology including GPS, computers and cameras. Some noted the GIS platforms they are utilizing as well. ESRI products appear to top the list of software being utilized. With regard

to costs the majority of respondents indicate that the investment in software and hardware is less than $15,000. Those that selected “other” suggest that they do not know the cost of their investment or have not proceeded with implementation. One respondent identified that the investment far exceeded the selection points in the survey.

Research Question 3 Results

What training and education is required to implement GIS technology for improving damage assessment? Survey questions 7 and 8 were utilized to gather information regarding this. For survey question 7, it was requested that respondents provide written responses that identify the type of training that was required to allow personnel to utilize the equipment and associated software. These written responses can be found in Appendices E, G and I under question 7. Responses to survey question 8 are identified in Table 8.

Table 8

Survey Question 8: How many contact hours were invested in training of personnel to use the GIS software and hardware?

	(Frequency/Percent)		
Survey Group	8 hours or less	9-16 hours	Other
MML	3/42.9%	0/0.0%	4/57.1%
EAFSOEM	2/28.6%	1/14.3%	4/57.1%
IMAGIN	3/27.3%	2/18.2%	6/54.5%

Note: To view responses for respondents selecting other, see question 8 in Appendices E, G & I.

With regard to training, written responses to question 7 it is noted that the type of training ranges from basic GIS courses to on the job training for IDA. Some mention ongoing training and scenarios for continuing education. As for contact hours it is noted the total number utilized for training is less than 16 for the majority of respondents across survey groups. There are some variations however these appear to be organizations that are identifying training hours for GIS operation and not IDA training for GIS. Many that did respond did not know how many hours were invested in training.

Research Question 4 Results

How have other organizations incorporated GIS into their damage assessment programs? Survey questions 9 and 10 were utilized to identify components relating to the human factors that can impact implementation of GIS technology into their IDA processes. Survey question 5 does provide some guidance on implementation with regard to equipment and software. Responses to survey question 9 are contained in Table 9.

Survey question 10 requested that respondents provide their comment in writing. Due to the number and size they have been placed in appendices that are respective of each Survey Group and can be found in Appendices E, G and I under question number 10.

The review of responses for survey question 9 indicates that the process of conducting IDA with GIS is well received. The exception to this is one EAFSOEM respondent that indicated that this was rejected. There does not appear to be any significant issues regarding the impact of organizational culture on the implementation of GIS technology for IDA. One exception is an EAFSOEM respondent who stated, in response to question 10, that older members of the department are not computer friendly. A second response indicated that some do not believe that IDA are not a priority in their job.

Table 9

Survey Question 9: How well did personnel receive technology advances in conducting damage assessments through the use of GIS technology?

(Frequency/Percent)

Survey Group	Very received	Received	Not well received	Rejected
MML	1/50.0%	1/50.0%	0/0.0%	0/0.0%
EAFSOEM	3/42.9%	3/42.9%	1/14.3%	0/0.0%
IMAGIN	4/40.0%	6/60.0%	0/0.0%	0/0.0%

Discussion

This research effort has revealed a number of items pertaining to the adaptation of GIS to IDA. GIS has been used through history to correlate data with geographical information. It has been utilized to track the spread of disease (Antonia-Brovelli, 2011), create a plan for a cancer prevention program (Lubenow & Tolson, 2001) and rebuild a war stricken country (El Sayed, 2007). Fire agencies are currently utilizing GIS to identify and pre-plan hazards that exist in their communities (Oliver, 2011). In addition to these uses, it is strongly indicated that GIS is already part of the emergency management process and is applicable the phases of response and recovery which include damage assessment processes (Cova, 1999; Johnson, 2000; Klitz & Smith, 2011). Some jurisdictions in Michigan and a limited group of fire service professionals indicate that they do utilize GIS at this time and a number of them suggest that they have incorporated it into

their damage assessment processes. Based on the literature and data gathered it is apparent that GIS is applicable to the immediate damage assessment process.

To implement a process that combines GIS and damage assessment requires appropriate funding and access to the appropriate hardware and software to be successful. The primary costs associated with the implementation are related to the GIS platform. Short (2011) identified that administrators from Franklin County, Alabama believed that their $170,000 investment was justified when it was utilized during for damage assessment following a significant tornado event. The City of Holland has invested close to $1 million dollars over a 24 year period just in GIS (M. VanDyken, 2012). The costs for incorporation of IDA into the platform should be significantly less.

The adjuncts that bring IDA to the GIS platform are already quite familiar to most agencies. Patterson (n.d.) notes that IDA of a wildfire was conducted using digital cameras with video capability, GPS and handheld computers. This combined with examples of available software for IDA that includes Geocove's ARM 360 ("GIS GPS and Wireless", 2011), ESRI's Public Safety Damage Assessment project (ESRI, n.d.), and other mobile technology (McKenna, 2010) provides adequate possibilities for the City of Holland to consider.

Costs identified by survey respondents indicate that investments for IDA software and hardware are less than $15,000. With consideration to the costs already incurred by the City of Holland and HBPW adapting GIS to IDA is justifiable.

When implementing GIS for IDA, consideration must be given to training requirements. It is noted in the literature that training can range from 2 days of training (McDowell & Moore, 2002) to simple on the "just in time training" (Klitz & Smith, 2011, p. 2). This is consistent with survey results that indicate that some personnel received on the job training and some reporting

ten minutes or less. It is clear however that most training was identified as taking less than 16 hours. Based on this training should not create a barrier for agencies that are contemplating the implementation of GIS for IDA.

A final item to consider is how other organizations have implemented GIS for IDA. The literature provides plenty of examples which include the NYSDOT where they have incorporated IDA and GIS to survey road damage (Road Status and Damage Assessment Tool, 2010). Others have been on the front lines of significant weather events such as tornados in Tuscaloosa, Alabama (Short, 2011) and in Fenton, Michigan (City of Fenton Michigan, 2009). This technology was implemented during the recovery efforts in New Orleans following Hurricane Katrina (Hampton & Webb, 2005). Survey respondents, although not specific on how they implemented GIS technology for IDA suggests that it is received well by personnel that utilize it. Some respondents indicate that their organizational culture is challenged due to the belief that IDA are not part of their perceived scope of work. This however does not have a direct impact on the implementation of GIS for IDA.

With careful consideration of the information gathered through this research effort the author has identified that GIS is applicable to the damage assessment process and can be utilized to develop a needed immediate damage assessment process (Szakacs, 2009) that leverages GIS investments already made in the City of Holland. By applying GIS to a new damage assessment process for the Holland Department of Public Safety, it is expected that it will improve and enhance the timely collection of information gathered during IDA following an incident or disaster.

Recommendations

Pursuant to a review and analysis of the survey data and literature review, the following recommendations are offered for consideration. The recommendations provide some suggestion for the implementation of an IDA that incorporates GIS and attempts to make judicious use of this research effort.

Recommendation 1: Identify Current Capabilities and Assess Needs

Identify the current GIS capabilities of the City of Holland and HBPW and conduct a needs assessment to determine needed hardware and software for adapting GIS to the immediate damage assessment process. This will include identifying funding sources within the City of Holland budget to purchase needed hardware and software.

Recommendation 2: Create Partnerships with GIS Operators at the City of Holland and HBPW

To be successful in adapting GIS to IDA it will be necessary to develop good working relationships with key stakeholders in the City of Holland. These personnel have the expertise and institutional knowledge to work with the Department of Public Safety to develop an IDA that benefits both entities as well as the community served.

Recommendation 3: Identify Agencies that Have Successfully Incorporated GIS and IDA

A shortcoming of this research effort was the inability to gather valid and confident data about how agencies and jurisdictions in Michigan utilize GIS for IDA applications. This can be accomplished by offering a shorter survey to a more defined group of potential respondents. Once identified it is recommended that interviews be conducted of key representatives from these agencies and jurisdictions to obtain the information that was not effectively gathered through this research effort.

Recommendation 4: Assess the Training Needs of Personnel

To be successful, personnel involved with conducting IDA must understand the fundamentals of the IDA process prior to adopting new technology. It is unknown what the level of understanding is of both GIS and IDA of current members of the Holland Department of Public Safety. An assessment will be important to identifying the amount of training needed to successfully implement and IDA program that utilizes GIS.

Recommendation 5: Seek Improvements in Research Methodology

This research effort was descriptive and utilized survey procedures to identify answers to defined research questions. Although the survey contained questions that would gather needed information, many of the survey questions were not parallel to the research questions and did not offer relevant data. The careful development of survey questions that directly answer the research questions will provide improved data.

A second suggestion in this area is to utilize interviews or focus groups to gather data and information that answers the research questions more effectively. This research effort was greatly impacted by the minimal response to survey requests. Alternative procedures may allow other researchers to overcome obstacles created by surveys.

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Appendix A

Survey Letter to Michigan Municipal League Members

City of Holland
Department of Public Safety
Fire Services
279 Kollen Park Drive
Holland, Michigan 49423
Safety, Prevention and Service through Community Partnership, Law Enforcement, and Fire Protection

November 15, 2011

Dear City or Village Representative,

The purpose of this correspondence is to request your assistance with gathering information pertaining to the use of Geographic Information System (GIS) Technology to enhance the Immediate Damage Assessment process. This is a common process that must be conducted during the response phase of any natural or manmade disaster.

This 10 question survey will take approximately ten minutes or less to complete however will be instrumental in gathering information that will assist the City of Holland in determining how to make further use of its' current GIS Technology. The survey data will also assist this researcher with the completion of an applied research project (ARP) that is a required component of the Executive Fire Officer Program that is administered by the United States Fire Administration's, National Fire Academy in Emmitsburg, Maryland.

It is requested that your responses be provided by Friday, December 16, 2011. Thank you in advance for your anticipated assistance with the survey. Your input is valued and important to the outcome of this project. Should you have any questions regarding the survey please contact me at (616) 355-1023. If you desire a copy of the data obtained from this survey, send your request to c.tinney@cityofholland.com.
The following link will take you to the survey: http://www.surveymonkey.com/s/MRQF5RZ . If this does not work you may cut and paste the link into your browser to take you to the survey page.
Respectfully,

Christopher M. Tinney

Appendix B

Survey Letter to EAFSOEM Students and IMAGIN Members

City of Holland
Department of Public Safety
Fire Services
279 Kollen Park Drive
Holland, Michigan 49423
Safety, Prevention and Service through Community Partnership, Law Enforcement, and Fire Protection

January 29, 2012

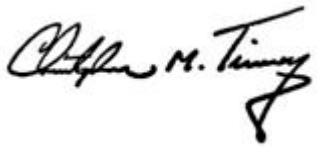
Dear Survey Participant:

The purpose of this correspondence is to request your assistance with gathering information pertaining to the use of Geographic Information System (GIS) Technology to enhance the Immediate Damage Assessment process. This is a common process that must be conducted during the response phase of any natural or manmade disaster.

This 10 question survey will take approximately ten minutes or less to complete however will be instrumental in gathering information that will assist the City of Holland in determining how to make further use of its' current GIS Technology. The survey data will also assist this researcher with the completion of an applied research project (ARP) that is a required component of the Executive Fire Officer Program that is administered by the United States Fire Administration's, National Fire Academy in Emmitsburg, Maryland.

It is requested that your responses be provided by February 29, 2012. Thank you in advance for your anticipated assistance with the survey. Your input is valued and important to the outcome of this project. Should you have any questions regarding the survey please contact me at (616) 355-1023. If you desire a copy of the data obtained from this survey, send your request to c.tinney@cityofholland.com . The following link will take you to the survey: http://www.surveymonkey.com/s/PF9F97P . If this does not work you may cut and paste the link into your browser to take you to the survey page.

Respectfully,



Christopher M. Tinney
Captain of Fire Operations

Appendix C

Survey Provided to MML, EAFSOEM Students and IMAGIN Members

GIS Adaptations For Improved Immediate Damage Assessments

Geographic Information System (GIS) Adaptations for Improved Immediate Dama...

Thank you for your willingness to participate in this survey. For clarity purposes the following definitions are provided:

Immediate Damage Assessment: This refers to a rapid estimate of damage at a specific incident site or within an incident area. It is made upon initial arrival and the information obtained during the immediate damage assessment is used for a variety of purposes during the active phase of the incident.

Preliminary Damage Assessment: A preliminary damage assessment or PDA is a detailed examination and analysis of all damage at a particular incident site or area. It is conducted after the active phase of the incident has been terminated. The process is conducted by local, county, State and FEMA officials and is conducted with 36 hours.

The purpose of this survey is to gather information that is specific to Immediate Damage Assessments.

Thank you again for your assistance.

*** 1. Does your city or village conduct immediate damage assessments following natural or man made disasters?**

- ◯ Yes
- ◯ No

2. Who conducts Immediate Damage Assessments in your city or village?

- ☐ Fire Personnel
- ☐ Police Personnel
- ☐ CERT (Community Emergency Response Team)
- ☐ Assessors Office

*** 3. Do you currently have GIS (Geographic Information System) technology in use in your city or village?**

- ◯ Yes
- ◯ No

4. If you ansered yes to question #3, do you utilize GIS Technology to assist with Immediate Damage Assessments?

- ◯ Yes
- ◯ No

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GIS Adaptations For Improved Immediate Damage Assessments

5. If you utilize GIS Technology for Immediate Damage Assessments, what hardware and software was needed to successfully implement it's' use? (Please note GPS, computers, servers and specific software needed)

Software Needed:

Hardward Needed:

6. How much has your city or village invested in adapting GIS Technology to enhancing damage assessment practices?

- ◯ Less than $5,000
- ◯ $5,000 to $10,000
- ◯ $10,000 to $15,000
- ◯ Other (please specify)

7. What type of training was required for personnel to competently utilize the equipment and software needed to conduct the damage assessment process with GIS Technology?

8. How many contact hours were invested in training of personnel to use the GIS software and hardware?

- ◯ 8 hours or less
- ◯ 9 to 16 hours
- ◯ Other (please specify)

9. How well did personnel receive technological advances in conducting damage assessments through the use of GIS Technology?

- ◯ Very well received
- ◯ Received
- ◯ Not well received
- ◯ Rejected

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GIS Adaptations For Improved Immediate Damage Assessments

10. Is there anything about the organizational culture of your city or village that helped or hindered the implementation of GIS Technology for the purpose of conducting damage assessment? Please enter any comments you have in the textbox below.

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Appendix D

Detailed Data & Results of Survey Procedures for MML Members

1. Does your city or village conduct immediate damage assessments following natural or manmade disasters?

Yes	14	77.8%
No	4	22.2%

2. Who conducts Immediate Damage Assessments in your city or village?

Fire Personnel	7	50.0%
Police Personnel	7	50.0%
CERT	3	21.4%
Assessor's Office	5	35.7%

3. Do you currently have GIS (Geographic Information Systems) technology in use in your city or village?

Yes	11	61.1%
No	7	38.9%

4. If you answered yes to question #3, do you utilize GIS technology to assist with Immediate Damage Assessments?

Yes	2	15.4%
No	11	84.6%

5. If you utilize GIS technology for Immediate Damage Assessments, what hardware and software was needed to successfully implement its' use? (Please note GPS, computers, servers and specific software needed) *Note. Written responses to this question can be found in Appendix E.*

6. How much has your city or village invested in adapting GIS technology to enhancing damage assessment practices?

Less than $5,000	5	50.0%
$5,000 to $10,000	0	0.0%
$10,000 to $15,000	0	0.0%
Other (please specify)	5	50.0%

Note. Written responses to this question can be found in Appendix E.

7. What type of training was required for personnel to competently utilize the equipment and software needed to conduct the damage assessment process with GIS technology?

Note. Written responses to this question can be found in Appendix E.

8. How many contact hours were invested in training of personnel to use the GIS software and hardware?

8 hours or less	3	42.9%
9-16 hours	0	0.0%
Other (please specify)	4	

Note. Written responses to this question can be found in Appendix E.

9. How well did personnel receive technology advances in conducting damage assessments through the use of GIS technology?

Very well received	1	50%
Received	1	50%
Not well received	0	0.0%
Rejected	0	0.0%

10. Is there anything about the organizational culture of your city or village that helped or hindered the implementation of GIS technology for the purpose of conducting damage assessment? Please enter any comments you have in the textbox below.

Note. Written responses to this question can be found in Appendix E.

Appendix E

Survey Comments from MML Members

Survey Questions 5, 6, 7, 8 and 10

Survey respondents were able to provide written responses to questions where the option was provided. This option was allowed for questions 5, 6, 7, 8 and 10 of the survey provided to this targeted group. Below the question is provided as well as a listing of comments provided.

5. If you utilize GIS technology for Immediate Damage Assessments, what hardware and software was needed to successfully implement its' use? (Please note GPS, computers, servers and specific software needed)
    - NA
    - NA
6. How much has your city or village invested in adapting GIS technology to enhancing damage assessment practices?
    - NA
    - This is not known. Damage Assessment was added after the GIS backbone was created.
    - nOTHING *(sic)*
    - Zero
    - Have not needed to use GIS for this purpose
7. What type of training was required for personnel to competently utilize the equipment and software needed to conduct the damage assessment process with GIS Technology?
    - NA
    - Basic GIS classes
    - N/A

- None
- Na
- See above

8. How many contact hours were invested in training of personnel to use the GIS software and hardware?

- None at this time
- NA
- Assessors assisted by other technology staff
- NA

10. Is there anything about the organizational culture of your city or village that helped or hindered the implementation of GIS technology for the purpose of conducting damage assessment? Please enter any comments you have in the textbox below.

- Slated to be a future project.
- NA
- GIS technology would be used by our County Damage assessment personnel under our County Emergency plan. Also our building division personnel assist with damage assessment
- N/A
- GIS technology hs *(sic)* been used to support preliminary damage assessment activities. In 2012, GIS technology and support ahs *(sic)* been added to the EOC operations and procedures to support immediate damage assessments.

- We partner with our County Emergency Management Division which they may have developed a GIS Program for Damage Assessment but locally we don’t. The big issue as with everything else is money and prioritization.

Appendix F

Detailed Data & Results of Survey Procedures for EAFSOEM Students

1. Does your city or village conduct immediate damage assessments following natural or manmade disasters?

Yes	6	75.0%
No	2	25.0%

2. Who conducts Immediate Damage Assessments in your city or village?

Fire Personnel	6	85.7%
Police Personnel	2	28.6%
CERT	1	14.3%
Assessor's Office	1	14.3%

3. Do you currently have GIS (Geographic Information Systems) technology in use in your city or village?

Yes	8	100.0%
No	0	0.0%

4. If you answered yes to question #3, do you utilize GIS technology to assist with Immediate Damage Assessments?

Yes	4	50.0%
No	4	50.0%

5. If you utilize GIS technology for Immediate Damage Assessments, what hardware and software was needed to successfully implement its' use? (Please note GPS, computers, servers and specific software needed) *Note. Written responses to this question can be found in Appendix G.*

6. How much has your city or village invested in adapting GIS technology to enhancing damage assessment practices?

Less than $5,000	2	28.6%
$5,000 to $10,000	0	0.0%
$10,000 to $15,000	4	57.1%
Other (please specify)	1	14.3%

Note. Written responses to this question can be found in Appendix G.

7. What type of training was required for personnel to competently utilize the equipment and software needed to conduct the damage assessment process with GIS technology?

Note. Written responses to this question can be found in Appendix G.

8. How many contact hours were invested in training of personnel to use the GIS software and hardware?

8 hours or less	2	28.6%
9-16 hours	1	14.3%
Other (please specify)	4	57.1%

Note. Written responses to this question can be found in Appendix G.

9. How well did personnel receive technology advances in conducting damage assessments through the use of GIS technology?

Very well received	3	42.9%
Received	3	42.9%
Not well received	1	14.3%
Rejected	0	0.0%

10. Is there anything about the organizational culture of your city or village that helped or hindered the implementation of GIS technology for the purpose of conducting damage assessment? Please enter any comments you have in the textbox below.

Note. Written responses to this question can be found in Appendix G.

Appendix G

Survey Comments from EAFSOEM Students

Survey Questions 5, 6, 7, 8 and 10

Survey respondents were able to provide written responses to questions where the option was provided. This option was allowed for questions 5, 6, 7, 8 and 10 of the survey provided to this targeted group. Below the question is provided as well as a listing of comments provided. The following comments were provided by EAFSOEM Students.

5. If you utilize GIS technology for Immediate Damage Assessments, what hardware and software was needed to successfully implement its' use? (Please note GPS, computers, servers and specific software needed)

   Software Needed:

   - Not certain. (I Mobile? Technology)
   - ArcGIS, Visinet CAD
   - ARCGIS Suite, ARCGIS Server
   - Application was developed internally that runs on Windows OS

   Hardware Needed:

   - Toughbooks, wireless (Verizon server)
   - Dedicated GIS computer, Visinet CAD MDT, GPS/GIS plotter and printer,
   - Server (2) work stations
   - Runs on existing notebook and tablet PCs

6. How much has your city or village invested in adapting GIS technology to enhancing damage assessment practices?

   - Existing program integrated into EOC operations

7. What type of training was required for personnel to competently utilize the equipment and software needed to conduct the damage assessment process with GIS Technology?

- OJT
- 8 hours initial training, and training as update occur
- ArcGIS training (with continuing education and module specific courses), specific criteria training for field personnel in IDA categories and procedures
- Unknown
- 10 minutes for field personnel 60 minutes for supervisory personnel

8. How many contact hours were invested in training of personnel to use the GIS software and hardware?

- 8 hours per class until all were up to speed
- At least 40 for the initial courses and currently 12-24 hours annually depending on the specific module needed
- Existing Program
- unknown

10. Is there anything about the organizational culture of your city or village that helped or hindered the implementation of GIS technology for the purpose of conducting damage assessment? Please enter any comments you have in the textbox below.

- Older members that are not computer friendly can hamper the learning and use process.
- The damage assessment process we currently are implementing is very difficult for field responders to accept as it is viewed as conflicting with the traditional tasks of suppression, treatment and rescue. We have bridged this obstacle by highlighting the

value of DA and how it supports the overall mission and makes the field tasks easier when resources are needed. Further, IDA has been incorporated into the response model as much of the information can be logged while en route to the assigned zones. The use of CAD to ease the processes and authenticate the GPS locations has been successful as this data can be transferred directly into ArcGIS. I don't know how, but my GIS and dispatch tech people say it can and we have tested it. Good luck Chris. Give me a call if you need to speak with my GIS or CAD folks. This is a new process for us so we are working out some kinks, but it is better than what we did before, which was nothing. Ed

- Out Fire Department is supported by an IT Division of the City. This division is extremely innovate and supportive of EOC operations as is all city staff. This culture has allowed the fire department to integrate into existing programs and systems to facilitate a more responsive damage assessment mode, taking advantage of current City facilities and technology.
- GIS is handled by Public Works Department.
- Our department has experienced extensive turnover in the last four years. The office corps has completely turned over and all new personnel are technically literate and early adopters of technology.

Appendix H

Detailed Data & Results of Survey Procedures for IMAGIN Members

1. Does your city or village conduct immediate damage assessments following natural or manmade disasters?

Yes	12	80.0%
No	3	20.0%

2. Who conducts Immediate Damage Assessments in your city or village?

Fire Personnel	5	45.5%
Police Personnel	4	36.4%
CERT	5	45.5%
Assessor's Office	6	54.5%

3. Do you currently have GIS (Geographic Information Systems) technology in use in your city or village?

Yes	15	100.0%
No	0	0.0%

4. If you answered yes to question #3, do you utilize GIS technology to assist with Immediate Damage Assessments?

Yes	10	71.4%
No	4	28.6%

5. If you utilize GIS technology for Immediate Damage Assessments, what hardware and software was needed to successfully implement its' use? (Please note GPS, computers, servers and specific software needed) *Note. Written responses to this question can be found in Appendix I.*

6. How much has your city or village invested in adapting GIS technology to enhancing damage assessment practices?

Less than $5,000	4	33.3%
$5,000 to $10,000	1	8.3%
$10,000 to $15,000	1	8.3%
Other (please specify)	6	50.0%

Note. Written responses to this question can be found in Appendix I.

7. What type of training was required for personnel to competently utilize the equipment and software needed to conduct the damage assessment process with GIS technology?

Note. Written responses to this question can be found in Appendix I.

8. How many contact hours were invested in training of personnel to use the GIS software and hardware?

8 hours or less	3	27.3%
9-16 hours	2	18.2%
Other (please specify)	6	54.5%

Note. Written responses to this question can be found in Appendix I.

9. How well did personnel receive technology advances in conducting damage assessments through the use of GIS technology?

Very well received	4	40.0%
Received	6	60.0%
Not well received	0	0.0%
Rejected	0	0.0%

10. Is there anything about the organizational culture of your city or village that helped or hindered the implementation of GIS technology for the purpose of conducting damage assessment? Please enter any comments you have in the textbox below.

Note. Written responses to this question can be found in Appendix I.

Appendix I

Survey Comments from IMAGIN Members

Survey Questions 5, 6, 7, 8 and 10

Survey respondents were able to provide written responses to questions where the option was provided. This option was allowed for questions 5, 6, 7, 8 and 10 of the survey provided to this targeted group. Below the question is provided as well as a listing of comments provided. The following comments were provided by IMAGIN Members.

5. If you utilize GIS technology for Immediate Damage Assessments, what hardware and software was needed to successfully implement its' use? (Please note GPS, computers, servers and specific software needed)

Software Needed:

- Unknown at this time
- ARCH GIS, Microsoft Office
- ArcView, Patherfinder,
- ArcMap
- Trimble Utility Center
- web based GIS application to allow data entry
- ESRI ArcGIS
- ESRI ArcView
- ArcGIS, Azteca Cityworks, Trimble, SCADA, Synergee,
- ArcGIS for Desktop, ArcReader, Windows XP OS, ArcPad
- we use ArcView 9.3 - going to 10.0

Hardware Needed:

- GPS
- Computer, GPS camera, Adapx Pen, GPS Garmen
- GPS, tablets, laptops,
- SQL Sever
- Leica GPS, HP Plotter
- Local server and EOC laptops
- Computers, servers
- Toughbook PCs, Ruggedized Tablets, Smart Phones
- computers, 2 large plotters, website, scanners

6. How much has your city or village invested in adapting GIS technology to enhancing damage assessment practices?

- Future Implementation
- Million plus
- part of citywide gis effort
- Our expenses include software, maintenance, and the development of data layers within the system. Total investment is shared with other users, but is well above your listed categories.
- Unknown, but more than any answer provided
- Don't know - done through regular budget processes & grants

7. What type of training was required for personnel to competently utilize the equipment and software needed to conduct the damage assessment process with GIS Technology?

- Future Implementation

- A couple of hours
- None
- GIS staff on Damage assessment team
- Will need to develop a program for damage assessment
- Because of simple nature of GIS application, 1 hour overview
- Simulations with our Emergency Operations Center provided "live" training scenarios
- We rely on our GIS Coordinators who already have the training necessary to complete damage assessment tasks using relevant equipment and software.

8. How many contact hours were invested in training of personnel to use the GIS software and hardware?

- Unknown at this time
- Used existing GIS staff
- Training of FD staff performed by FD trainer, GIS provided training to FD trainer
- See number 7.
- GIS personnel have years of experience using and manipulating the data to show damage assessments
- Unknown

10. Is there anything about the organizational culture of your city or village that helped or hindered the implementation of GIS technology for the purpose of conducting damage assessment? Please enter any comments you have in the textbox below.

- No. We have progressive leadership, and most staff recognize the benefits of GIS. This will be a project to implement in the future.
- Our county fully implements GIS.
- The Utlility brought and converted records. Have City and Utilities share information. City and Utility are willing to look at new technology
- Having a simple to use, purpose built application for fire fighters to use is very important. If the application isnt absolutely dead simple to use fire fighters wont use it.
- None known. In fact, our EOC welcomed the use of GIS as a new damage assessment tool. The ability to provide near, real-time map output of damaged areas and the extent of said damage, assisted greatly in our EOC simulations. The information also aided the Public Relations contact to accurately report the situation to the public without causing undue alarm.
- From the beginning local government recognized the benefits GIS could bring to emergency management and response. It was expected to be utilized for these purposes from the beginning of the GIS program.
- Often times key personnel responsible for reporting damage assessments are not aware of the power and potential that GIS hardware, software and personnel are capable of. They often times are overlooked for and under utilized during times of great need.
- Start with fulfilling an immediate need(s) quickly and prioritize investments by balancing short-term and long-term benefits. Invest because collective benefit is recognized and led by competent and experienced professionals. The adoption of GIS technology is evolutionary and not simply a destination. Teams need to continually reinvest time and focus to keep data current, relevant, and operationally ready. GIS provides a rich toolset

which when complemented by public safety management expertise can be very effective. Listen to your own people on the front lines USING the technology. Do not assume vendors' claims and higher levels of government appear to have all of the answers. Remember - the first 72 hours are on you and your teams ability to effectively respond.