An Analysis of State Emergency Management Agencies' Hazard Analysis Documents on the Internet

Seong Nam Hwang

William Sanderson

Michael K. Lindell

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Hazard Reduction & Recovery Center

Texas A&M University

College Station TX 77843-3137

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This study examined hazard analysis information on state emergency management agencies' (SEMAs') Internet websites. The results showed that 3 of the 51 SEMAs in the United States did not have websites accessible to the public and another 13 provided no hazard analysis information on their websites. Among those that do provide information about hazards, most address relatively few of the hazards to which their states are vulnerable. Moreover, there is poor correspondence of the hazard agents addressed on SEMA websites with either long-term vulnerability determined from hazard maps or recent impacts defined by federal major disaster declarations. This suggests that states are missing a major opportunity to educate local emergency managers and the public about the hazards to which they are vulnerable. Several recommendations are made for improving the content and format of hazard analysis information on SEMAs' websites.

The past twenty years have seen a steadily increasing impact of information technology as federal, state, and local agencies have increased their use of computers to solve problems in all phases of emergency management. Much of the early emphasis was on the use of emergency management information technology (EMIT) to develop decision support systems in the response phase of disasters. This was the topic for the majority of contributors to a seminal book edited by Marston (1986). Another application that has received increasing attention is the use of computers for conducting hazard/vulnerability analyses. Researchers have described how computers can be used to identify areas at risk (Dash, 1997; Griffith, 1986; Berke, Larsen and Ruch, 1984) and to project the damages resulting from a major incident (French, 1986; Haney, 1986; Scawthorne, 1986).

These reports provide important indications that advanced information technology is available to emergency managers, but they fall short of describing the extent to which EMIT actually has been adopted. Moreover, it would be useful to determine if different forms of this technology vary in their rates and extent of adoption. If so, what are the reasons for these differences? Similarly, it is likely that there are differences among emergency management agencies in their extent of EMIT adoption. If so, what are the attributes of these agencies that account for these differences?

Unfortunately, there are very limited data to answer these questions about the adoption of EMIT in general and hazard/vulnerability analysis in particular. An early survey of EMIT adoption by police and fire agencies in California was conducted by Bradford and Brady (1984, 1986), who found that 79% of the departments supported the use of computers in emergency management, 71% planned to use computers more extensively in the next three years, and 91% of the respondents were personally interested in learning to use computers in emergencies. This survey also listed emergency managers' reports of benefits associated with computer usage. These included improving emergency planning, delivery of emergency services, and coordination and communication between organizations. However, the authors did not indicate the extent to which different forms of EMIT had been adopted or the characteristics of agencies that led to the adoption of these innovations.

A more recent survey of hazard-related organizations addressed the utilization of different types of information technology by earthquake hazard researchers. Coty and Stoyle (1994) found that word processing software was utilized most, followed by analytical software, computer assisted design, and Geographical Information Systems (mainly ARC/INFO). The authors also noted the widespread use of networks. Many survey respondents were using some type of e-mail (45%), local area networks (40%), and the Internet (31%). Moreover, half of the respondents utilized the Internet for e-mail and 20% used it for databases. However, the authors did not examine the reasons for the difference in the rates of adoption. Coty and Stoyle (1994) also reported that only 10% of their survey respondents rated themselves as "novices" in computer knowledge. Another 50% rated themselves as "intermediate", 32% rated themselves as "advanced", and 6% rated themselves as "experts". These data provide some insights into computer use in emergency management, but many of the users were academic researchers and, thus, may not shed light on the extent to which these innovations have been adopted by federal, state, and local level emergency managers.

Lindell and Perry (in press) reported data from Local Emergency Planning Committee (LEPC) Chairs in Illinois, Indiana, and Michigan indicating that 36% had used computer models such as CAMEO (National Safety Council, 1995) or ARCHIE (Federal Emergency Management Agency, no date) to analyze their communities' vulnerable zones (VZs). However, only 59% of the LEPCs had calculated VZs. Thus, almost two-thirds of the LEPCs that had calculated VZs used computer-based methods to do so. It is noteworthy that there are differences among jurisdictions in their use of computers for this purpose. Lindell, Whitney, Futch, Clause and Rogers (1994a, 1994b, 1994c) reported that Illinois LEPCs had a low level of computer use in hazard analysis, while Michigan LEPCs had an intermediate level, and Indiana LEPCs had the highest level. There also were differences among types of computer use. Indiana LEPCs also used computerized databases more extensively for hazard data and community emergency response resources than did Illinois and Michigan LEPCs. However, Illinois LEPCs were more likely to develop computers resource databases than were Michigan LEPCs.

The most directly relevant assessment of EMIT adoption was conducted by Drabek (1991), who interviewed personnel in the state emergency management agencies (SEMAs) for Florida, Louisiana, Pennsylvania, and Virginia, and also in twelve local emergency management agencies within those states. His study dealt with four major topics: 1) factors affecting the adoption and implementation of personal computers, 2) actual use of personal computer in emergency response, 3) computer impacts on the emergency management agencies, and 4) policy issues regarding computer usage. In addressing the first topic, Drabek (1991) found that the chief incentives for implementing computers were "increased office efficiency (e.g., word processing capability); networking potential; budget management; resource management; public warning/evacuation applications (e.g., flash flood warnings); automated emergency notification for staff; and decision support systems such as hurricane tracking" (1991, p.58). He also discovered several barriers slowing the process of installing computers in these agencies—insufficient numbers of trained staff, machine incompatibility, and inadequate availability of information about EMIT.

Regarding actual computer use in emergency response and disaster recovery (e.g., warning, evacuation, situation reports, communication and damage assessment), Drabek (1991) found that some emergency managers were using computers for each of these tasks. However, they also faced three major difficulties in this area as well: software inadequacies, staff shortages, and database-related problems.

In connection with computer impacts on emergency management agencies, Drabek (1991) also noted emergency managers were required to create new positions and new policies, redefine staff member responsibilities, and consider budget stability. He added that the implementation of computers helped strengthen the image of their agencies because of new capabilities, such as the refined appearance of documents and "reinforced centrality of emergency management agencies within the response network" (1991, p.115).

Finally, Drabek (1991) reported that all of the survey respondents agreed with three policy proposals. These included creating a national information clearinghouse, publishing a newsletter on the use of personal computers in emergency management, and augmenting federal funding for the implementation of computers in the emergency management.

In summary, previous research shows that a variety of information technologies were being employed in emergency management in the mid-1990s, but there was evidence of implementation barriers that impeded widespread use. In the years since this research was conducted, computer use has become even more widespread in offices through the country and the growth of the Internet in the 1990s was especially remarkable. The Internet had approximately 10 million users in 1993 and this number is estimated to grow to more than 1 billion by the end of 2000 (Tapscott, 1995). Unfortunately, it is unknown whether emergency managers have taken advantage of this increasing use of the Internet. One particularly important question is whether SEMAs are using this medium to disseminate hazard analysis information to local emergency managers and the public. There are three reasons why this is a particularly significant application of Internet technology. First, federal and state agencies have generated many hazard analysis documents, maps, and databases that already are in digital form and are available for SEMAs to put onto their websites. By providing local emergency managers and the public with information about their communities' vulnerability to natural and technological hazards, such products would satisfy SEMAs' existing needs for conducting state hazard analyses and disseminating their results. Second, SEMA websites can be linked electronically to other organizations' websites. This allows users to immediately access additional hazard analysis information that might otherwise take them months to obtain if they were to request it in paper copy. .Third, hazard analyses disseminated over the Internet can be updated frequently and, by avoiding the printing costs associated with hundreds of paper copies, can be disseminated less expensively. These three advantages of web-based dissemination of hazard analysis information suggest that there should be an examination of the extent to which SEMAs have established websites and are using them to disseminate information about the hazard agents to which their states are vulnerable. A systematic analysis of SEMAs' hazard information on the Internet will make an important first step toward a comprehensive assessment of the adoption of EMIT. More specifically, the aims of this study are to identify:

1. The number of SEMAs that have websites containing hazard analysis information,
2. The hazard agents most commonly addressed on those websites,
3. The secondary websites to which the SEMA websites themselves provide links, and
4. The correspondence of the hazards addressed on SEMAs' websites with their states' actual hazard vulnerability and recent disaster experience.

METHOD

The Internet was searched to locate the website for each SEMA (if it existed) and to determine if it contained hazard analysis information. A website was judged to contain hazard analysis information if it described a hazard agent (e.g., hurricane, earthquake, tornado) or protective responses (e.g., emergency preparedness, hazard mitigation) to a hazard agent. Information about the hazard agent itself could include scientific explanations of its origins and dynamics; locations at risk; impact characteristics such as speed of onset, scope and duration of impact; or temporal characteristics such as frequency, probability, or seasonal predictability of impact. Information about protective response could include checklists of protective actions, methods of implementing these actions (e.g., instruction on how to construct hurricane storm shutters), and resources (e.g., specialized knowledge or tools) required for successful implementation.

Each SEMA's website was searched to determine the number of records (e.g., separately addressed locations) on each hazard agent. There were many cases in which SEMA websites contained no information that they themselves had produced and maintained. Instead, the SEMA website was linked to hazard analysis information on a website that was maintained by another source. For example, some SEMA websites are linked to FEMA's virtual library at <www.fema.gov/ library/lib07.htm>.

The information documented on the websites of the 50 states plus the District of Columbia was sufficient to answer the first three questions. However the fourth question, concerning the correspondence of SEMAs' websites with their states' actual hazard vulnerability and recent disaster experience, required additional data. Actual vulnerability was assessed by means of hazard maps that can be found in *Multihazard Identification and Risk Assessment* (Federal Emergency Management Agency, 1997). Data on recent disaster experience was obtained from the FEMA website <www.fema.gov/library/dis_graph.htm>, which lists all federally declared disasters since 1992. A SEMA's total number of records for each hazard agent on its website was compared to the total number of presidential disaster declarations that resulted from that hazard agent in that state from January, 1992 to September, 1999. It was expected that both actual vulnerability (as determined from FEMA hazard maps) and recent impact (as assessed by federal major disaster declarations) would make a given hazard agent more salient to state government and, therefore, more likely to be listed on a SEMA's web site.

RESULTS

The number of SEMA hazard analysis websites

There were 48 SEMA home pages that could be found on the Internet. No home pages were found for the Arkansas and West Virginia SEMAs, and the Hawaii SEMA's home page was restricted to users with an authorized password. Of the remaining SEMA websites, 13 had no hazard analysis information. These were the SEMA websites for Alabama, Delaware, District of

Columbia, Iowa, Massachusetts, Minnesota, Mississippi, Missouri, Nebraska, Nevada, New Jersey, New Mexico, and Tennessee.

Moreover, the number of hazard analysis records on these websites was far from uniformly distributed. The top seven SEMA websites (14% of the websites) accounted for approximately 53% of the hazard analysis records for all SEMA websites. The South Carolina website had the most hazard agent information, comprising 31 (9.7%) of the 321 records, followed by Florida (30 records, 9.3%), Michigan (27, 8.4%), Alaska (25, 7.8%), Wisconsin (21, 6.5%), Maine (19, 5.9%) and Rhode Island (16, 5.0%). Seven SEMAs had between eight and sixteen records and another 20 SEMA websites had fewer than eight records of hazard analysis information. As noted earlier, 17 SEMAs provided no hazard analysis information at all.

Hazard agents most commonly addressed

On the remaining 34 SEMAs' websites, there were 321 records of hazard analysis information. As noted earlier, a record was defined as a single address, regardless of the amount of information at that address. These 321 records addressed 23 different hazard agents. Table 1 lists each of the 23 hazard agents and the number of records associated with each of them. Hurricanes ranked first, accounting for 15.6% of all records, followed by earthquakes (12.5%), floods (10.3%), fires (9.0%), tornadoes (9.0%), and hazardous materials (8.4%). At the other extreme, six hazard agents—avalanche, erosion, blight, freeze, meteor and pollution—had just one or two records each. Nine of the records contained extraneous information such as an annual report, mitigation strategies, and mitigation success stories. These were classified into the category, "General". One of the SEMA websites addressed 18 hazard agents, including droughts, earthquakes, heats, fires, floods, hazardous materials, infrastructure failures, nuclear attack and radiological accidents, terrorism and snowstorms. However, this was accomplished by linking to a single secondary source—the FEMA virtual library at < www.fema.gov/ library/lib07.htm>.

Secondary websites

The SEMA websites were linked to 174 individual records on 93 secondary sources' websites. Here too, the number of hazard analysis records was far from uniformly distributed. Table 2 shows the secondary sources with more than 2 records and their percentage of the total number of links from SEMA websites. The three highest-ranked secondary sources accounted for a third of all links. FEMA received the most links (28), followed by the National Oceanographic and Atmospheric Administration (18), USGS (13), the American Red Cross with (5), and the U.S. Forest Service, the U.S. Department of Health and Human Services, and the Weather Underground all with 3 links apiece. Fifteen sources (16.1%) had two links apiece, and 71 sources (40.8%) received only one link from SEMA websites.

Hazard agent information from the most popular secondary source, FEMA's virtual library, included earthquakes, floods, hazardous materials, heat, hurricanes, landslides, radiological risks, terrorism, thunderstorms, and tornadoes. The NOAA hazard analysis websites covered fires, floods, hurricanes, tornadoes and tsunamis. The USGS hazard analysis website covered droughts, earthquakes, hazardous materials, landslides, and volcanoes. The American Red Cross website covered earthquakes, fires, storms, floods and hurricanes. These websites generally included information about the nature of the threat and some included information about protective measures, but it would be very difficult from these websites to determine the vulnerability of specific localities.

Analysis of SEMAs' Hazard Coverage

To assess the correspondence of SEMA websites' hazard analysis information with actual vulnerability and recent disaster experience, the data on states' vulnerability to six major hazards was determined using maps available from the Federal Emergency Management Agency's (1997) *Multihazard Identification and Risk Assessment* (see also the maps published by the USGS at <www.usgs.gov/themes/hazards/html>). Storm vulnerability was assessed by using the average duration of thunder events in the FEMA document's Map 2-1, while flood vulnerability was assessed by using Map 12-1 to identify states with more than 5000 households in the 100-year flood plain. Tornado vulnerability was measured by identifying those states having more than 90 tornadoes per one degree box during the period from 1954-1983 (Map 3-2). Hurricane vulnerability was indicated for states with any county having an annual probability greater than $p = .05$ of a Saffir-Simpson Category 1 hurricane (Map 1-2), earthquake vulnerability was indicated for states having an effective peak acceleration greater than .20 (Map 16-1), and landslide hazard was coded as present if any part of the state was indicated as being vulnerable to this hazard on Map 9-1.

A search of FEMA's website revealed that the federal government declared a total of 354 major disasters in the 50 states and the District of Columbia during the period from January, 1992 through September, 1999. This number excluded those in the Puerto Rico (4), the Marshall Islands (4), Micronesia (3), Guam (2), the Virgin Islands (3) and the Northern Marianas (1). The 354 declarations resulted from 474 incidents, arising from 12 kinds of hazard agents: blizzards, earthquakes, explosions, fires, floods, freezes, hails, hurricanes, landslides, storms, terrorism, and tornadoes. The number of declarations and the number of incidents differ because of cases in which two or more hazard agents accounted for a single declaration (i.e., a presidential declaration made for a storm that caused immediate wind damage and later flooding).

Storms—including snowstorms, coastal storms and winter storms—accounted for the most major disaster declarations (172 out of a total of 474). This was followed by floods (170), tornadoes (58), hurricanes (37), blizzards (17), fires (5), earthquakes (5), landslides (4), freezes (2) and explosion (2), hail (1) and terrorism (1). Many storms were accompanied by tornadoes and floods, and floods tended to be followed by landslides. Major disasters were declared, on average, 44 times per year from 1992 to 1999. If these disasters were distributed uniformly across states, there would have been approximately one declaration per state per year, or eight per state for the entire period being studied. In fact, the disaster declarations are far from uniformly distributed. The most declarations have been made for Florida (17 times), followed by California (14), Minnesota and Texas (13 each), and Alabama (12). At the other extreme, Colorado, the District of Columbia, Hawaii and Nevada experienced only two declarations apiece, whereas Arizona, Rhode Island, Utah and Wyoming experienced only one declaration each. In addition, the disasters were not uniformly distributed by year of occurrence. The worst year was 1996 with a total of 73, followed by 1998 with a total of 61. The larger number of disaster declarations in 1996 is due to the impact of 14 blizzards that affected multiple states. Similarly, the total for 1998 is inflated by the nine states affected by Hurricanes Bonnie and George.

Storm

All states are vulnerable to severe snow, coastal, or winter storms, and all but four (Arizona, Rhode Island, South Carolina and Utah) have received disaster declarations due to this hazard. These storms accounted for a total of 172 major disaster declarations. Nonetheless, only 17

SEMA websites had hazard analysis records for storms. Among 14 states with more than four declarations, only five SEMA websites (Illinois, Louisiana, Maine, North Dakota and South Dakota) had hazard analysis records for storms and these contained only one record apiece.

Flood

A total of 170 major disaster declarations due to flood occurred during the period from 1992 to September 1999, and these were distributed over 46 states. Although all states have some degree of flood vulnerability, 25 states were classified as having a major flood susceptibility to this threat. However, only 18 SEMA websites had hazard analysis records addressing flooding. Eight states each had more than five major disaster declarations: Missouri (8), Iowa (7), and Alabama, California, Indiana, Minnesota, North Dakota, and Washington (6 apiece), but had no hazard analysis records for flood. In addition, the states of Illinois, South Dakota and Vermont each had more than the six flood disaster declarations but the websites of these three states had only one flood record each. Three of the five states with no flood disaster declarations had hazard analysis records about floods—Rhode Island (4), Connecticut (1) and South Carolina (1). However, all of these states do have a significant flood hazard, as indicated by FEMA maps.

Tornado

There are 23 states that are vulnerable to tornadoes and there are 12 states that have received a total of 58 disaster declarations resulting from tornadoes, but there are only 17 states having a total of 29 records that address tornadoes. The SEMA websites in the 12 states with tornado disaster declarations contained no tornado hazard analysis records. Five states—Colorado, Maine, Maryland, North Dakota, and South Carolina—did not experience major disaster declarations for tornadoes, but did have tornado hazard analysis records on their websites. Two of these do have a significant tornado hazard vulnerability, as indicated by FEMA maps.

Hurricane

Thirteeen states meet the criterion for significant vulnerability to hurricane hazard and 17 states received a total of 37 hurricane disaster declarations from 1992 through 1999, but only 12 SEMA websites had records for hurricanes. Nonetheless, the 50 Internet records for hurricanes was larger than the number for any other hazard. The SEMAs in the two states (North Carolina and Florida) that received the most major disaster declarations (16% each), had 11 (22%) and 13 (27%) of the hurricane hazard analysis records, respectively. However, eight states—including Alabama, Connecticut, Delaware and Georgia, Mississippi, and New Jersey—have received one or more major disaster declarations for hurricanes but their SEMA websites had no hurricane hazard analysis records. Finally, three SEMAs—Maine, Michigan, and Rhode Island— had records for this hazard agent but received no disaster declaration for hurricanes from 1992 to 1999. Maine and Rhode Island have been affected by hurricanes in the past (Federal Emergency Management Agency, 1986), but Michigan was coded as having a hurricane hazard analysis record because its website linked to the FEMA multihazard library that contains a listing for hurricane hazard.

Earthquake

Sixteen SEMAs provided a total of 40 hazard analysis records for earthquakes, with Arizona having six, followed by South Carolina and Idaho with five apiece. Alaska and Illinois had four apiece and Washington had three. None of these six states had disaster declarations for earthquakes. Only two states, California (three times) and Oregon (twice), received earthquake disaster declarations during the period from January 1992 to September 1999. California's website had two records and Oregon's had one record. However, 16 states meet the criterion for effective peak acceleration greater than .20. This indicates that 11 states with a significant vulnerability have not provided information for this hazard on their SEMA websites. Conversely, there are two states, Wisconsin and New Hampshire, which are not considered to be at significant risk for earthquakes, but have two and one earthquake records, respectively.

Landslide

According to FEMA maps, there are 25 states vulnerable to landslides, and four states received major disaster declarations for landslides from 1992-1999. The Alaska SEMA, with no landslide disaster declarations, had three landslide hazard analysis records, while the SEMAs in three states (California, Maine and Washington) that have experienced at least two landslide disaster declarations apiece had no records for this hazard agent.

Correspondence hazard analysis records with vulnerability and experience

Table 3 displays the number of vulnerable states, the number of states with recent major disaster declarations, and the number of states with hazard analysis records for each of the six hazards. In addition, this table also displays the correlations of hazard vulnerability and recent disaster declarations with the number of hazard analysis records. The data indicate that hazard vulnerability and recent disaster experience are significant correlated with the number of hazard analysis records only for hurricanes. In addition, hazard vulnerability also is significant correlated with the number of hazard analysis records for earthquakes. None of the other hazards shows a significant correlation of hazard vulnerability and recent disaster declarations with the number of hazard analysis records.

DISCUSSION AND CONCLUSIONS

Examination of SEMAs' websites revealed that most, but certainly not all, provide some hazard analysis information. The most commonly addressed hazards are hurricane, earthquake, flood, fire, tornado, hazardous material, storm, terrorism, drought, and radiological material. This list includes some of the most significant hazards, but there are other hazards that should receive attention and many of the states that are vulnerable to the most common hazards fail to address them on their SEMA websites.

More specifically, an analysis of six highly probable or highly damaging hazards (storm, flood, tornado, hurricane, earthquake, and landslide) revealed the degree to which hazard analysis information on SEMA websites corresponded to their hazard vulnerability and recent disaster experience. The results show substantial variation across states and hazards in the adequacy of SEMA websites. Most of the SEMAs have failed even to address many common hazard agents on their websites and less common hazards such as tsunami, structure failures, landslides, and avalanche are generally neglected even thought they also have the potential for significant impacts. Some plausible explanations for the inadequate coverage of these hazard agents in SEMA websites are addressed below.

Some SEMAs may lack the resources to deliver information through the Internet. This is quite likely to be the problem for the two SEMAs having no website, but it might be having an impact on other SEMAs as well. Further data are needed to determine the specific problems, but previous research has documented that insufficient technical staff, as well as hardware and software limitations, are impediments to emergency management agency adoption of EMIT

(Drabek, 1991). These previous findings are consistent with the data reported here, which indicate that SEMAs with little or no hazard information on their websites tend to be those from rural states with small budgets. Thus, they have few financial resources for purchasing computer hardware and software and either hiring computer support staff or contracting with outside organizations for website development. One possible way of overcoming the problem of staff limitations would be for professional organizations such as the National Emergency Management Association or International Association of Emergency Managers to establish basic guidance for the development and maintenance of hazard analysis websites. The availability of hazard analysis information on SEMA websites could be significantly improved if one of these professional organizations were to establish a list of qualified contractors that could work with the states to upgrade their websites. A longer term solution would be for universities offering programs in emergency management to emphasize EMIT within their curricula so that state and local agencies would have a pool of applicants who are technically qualified in this area.

Some SEMAs may think a hazard analysis web site is unnecessary because people already know about most common hazards such as storms and floods. This rationale is entirely inappropriate because people frequently have inaccurate beliefs about hazards, misjudge their personal vulnerability, and lack information about methods of protecting themselves (Lindell and Perry, 2000; Lindell and Barnes, 1986; Slovic, Kunreuther & White, 1974). Indeed, it is precisely because local emergency managers and the public lack accurate hazard information that federal agencies such as FEMA and USGS disseminate this information.

Some SEMAs may not believe that the Internet is an effective method of disseminating hazard analysis information. There is some validity to this belief because Internet access, though extensive, is far from universal for local emergency managers and the public. Nonetheless, Internet access is rapidly becoming more widespread and the number of people who can be reached by this communications medium is becoming increasingly large. Moreover, as noted earlier, *cost-effectiveness* is a major incentive for SEMAs to increase their use of the Internet. SEMAs bear essentially no reproduction or distribution costs because users pay their Internet Service Providers for access to the website and there is a cost of printing only if the users decide hard copy is needed. Finally, electronic dissemination is advantageous for local emergency managers because they can "cut and paste" portions of the hazard analysis information from the SEMA website into their own local hazard/vulnerability analyses.

Some SEMAs may provide little hazard information on their websites because they already distribute this information through other media. This rationale has some validity because, for example, many states that are vulnerable to hurricanes distribute brochures containing maps of risk areas and hurricane survival tips. However, this explanation ignores the fact that hazard analysis information developed for distribution through other channels can be adapted quite readily and inexpensively to a website. Similarly, hazard analysis information received from other sources (e.g., Red Cross disaster preparedness brochures) is becoming available on those organizations' websites and SEMAs only need to establish a link to that information.

SEMAs might overlook hazard agents with which they have little or no recent disaster experience. This does not appear to be the case because more commonly experienced hazards such as storms receive less attention than more dramatic agents such as hurricanes and earthquakes. The problem seems to be that SEMAs simply are not providing enough hazard information themselves, or linking to others who do provide that information.

Conclusions. Most SEMAs are underutilizing an important channel for delivering hazard analysis information to local emergency managers and the public. As mentioned earlier, it is likely that the demand for web-based hazard information will increase over the time. According to FEMA (www.fema.gov), Internet users visited FEMA's hurricane-related websites more than 1.25 million times in a week after Hurricane Bertha hit the U.S. in 1996. Fischer (1998) mentioned that recognized authorities, such as emergency management agencies and major research centers could play an important role in disseminating hazard-related information. SEMA websites can play an important role in this effort by helping local emergency planners to collect needed information rapidly and easily. Additionally, a good SEMA website can help local residents recognize their vulnerability to natural and technological hazards. This can motivate them to adopt hazard adjustments that would reduce their vulnerability to these threats.

In the course of examining SEMA websites, it became clear that there were a number of recurring deficiencies. Some of these related to the content of the hazard analysis information, while other deficiencies arose from the way in which the web pages were structured. Table 4 lists 16 recommendations for improving the presentation of hazard analysis information on SEMA websites.

This analysis of SEMAs' websites has several limitations. First and foremost, this analysis equates the amount of hazard analysis information with the number of hazard analysis records (i.e., the number of separately addressed web pages). This unit of analysis could be misleading because the amount of information can vary from one record to another. However other measures, such as the number of lines of text or the number of words, would be no more satisfactory because they would require a large number of judgments about the relevance of each passage of text. One objective of future research on the dissemination of hazard analysis information should be to develop better measures of the amount of hazard information on a website.

Second, the basic data collected in this analysis may be changing over time because SEMA hazard analysis websites can be updated so easily . To some extent, this also would be a problem for an analysis of material distributed on paper, but it is more acute for websites because they can be updated almost continuously. Although frequent updating is a problem for research on websites, it is a practical advantage from the user's and the SEMAs' perspectives. The user benefits by getting more accurate information, whereas the SEMA benefits because frequent updating is an important way to maintain user interest; providing frequent updates can keep users coming back to see what is new on the site. This might be a particularly useful strategy for getting people to act on hazard analysis information because Lindell and Prater (in press) have found that hazard intrusiveness—the frequency of thought, discussion, and information receipt—is a strong predictor of hazard adjustment adoption.

Third, some hazard analysis websites were very difficult for ordinary users to search because they were linked to so many other websites that navigation was impeded. For this reason, a few indirect linkages had to be left out of the analyses, but the omission of these records is unlikely to have significantly influenced the conclusions. This difficulty suggests that hazard analysis websites be designed so that they make it easy for users to navigate through them.

Fourth, this study examined only one technology being used in emergency management. Emergency managers are using other information technologies such as cellular telephones, teleconferencing, and satellite communications (Tierney, 1994). They also are using specific software for hazard analysis such as GIS (Environmental Systems Research Institute, 2000), CAMEO (National Safety Council, 1995), and HAZUS (National Institute for Building Sciences, 1998). Future research also should examine the rate at which these other technologies are being adopted and the factors affecting their adoption.

Finally, this study did not examine the extent to which local emergency planners and the public have access to the hazard analysis information that is provided on the SEMA websites. Even the best websites are of little significance for those who lack access to the Internet or do not search for hazard analysis information on their SEMAs' websites. Moreover, this study also did not examine the extent to which local emergency planners and the public actually use this hazard analysis information. Further research is needed to assess the extent to which people search for hazard analysis information on the Internet and use it to reduce community hazard vulnerability.

In summary, the Internet provides SEMAs with an opportunity to increase their dissemination of emergency-related information to local emergency managers and the public. SEMAs can provide an important service by disseminating authoritative hazard analysis information to those who need it. However, researchers need to examine the flow of hazard information from SEMAs to local emergency managers and the public. Such research can identify ways to improve the dissemination and utilization of hazard analysis information and increase the adoption and implementation of effective hazard adjustments.

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Table 1: Hazard agents and their frequency of mention on SEMA websites

Hazard Agent	Records	Percent	Hazard Agent	Records	Percent
Hurricane	50	15.6%	Heat	8	2.5%
Earthquake	40	12.5%	Structure Failure	6	1.9%
Flood	33	10.3%	Tsunami	4	1.2%
Fire	29	9.0%	Landslide	3	0.9%
Tornado	29	9.0%	Explosion	3	0.9%
Hazardous Material	27	8.4%	Avalanche	2	0.6%
Storm	22	6.9%	Erosion	2	0.6%
Terrorism	15	4.7%	Blight	1	0.3%
Drought	14	4.4%	Freeze	1	0.3%
Radiological Material	13	4.0%	Meteor	1	0.3%
General	9	2.8%	Pollution	1	0.3%
Volcano	8	2.5%	Total	321	100.00

Table 2: Number of records and percentage of all links accounted for by each of the secondary sources with two or more records

Secondary Source	Records	Percent
Federal Emergency Management Administration	28	16.09
National Oceanographic and Atmospheric Administration	18	10.34
US Geological Survey	13	7.47
American Red Cross	5	2.87
US Department of Human Services	3	1.72
US Forest Service	3	1.72
Weather Underground	3	1.72
Centers for Disease Control and Prevention,	2	1.15
Department of Transportation	2	1.15
Environmental Protection Agency	2	1.15
Florida Division of Forestry	2	1.15
Institute of Global Environment and Society	2	1.15
National Drought Mitigation Center	2	1.15
National Fire Protection Association	2	1.15
New England States Emergency Consortium	2	1.15
North Carolina Emergency Management Agency	2	1.15
US Nuclear Regulatory Commission	2	1.15
Oklahoma Mesonetwork	2	1.15
Stormdisplay.com	2	1.15
Tornado Project	2	1.15
University of Illinois Dept. of Atmospheric Sciences	2	1.15
Weather Channel	2	1.15
Total	103	59.20

Note: Seventy one secondary sources (40.80%) have 1 hazard analysis record apiece.

Table 3: Number of vulnerable states, number of states with major disaster declarations, number of states with hazard analysis records, and correlations of hazard vulnerability and number of disaster declarations with number of hazard analysis records, by hazard.

Hazard	Number of vulnerable states	Number of states with major disaster declarations	Number of states with hazard analysis records	Correlation of vulnerability with hazard analysis records	Correlation of disasters with hazard analysis records
Storm	28	47	15	-0.12	-0.04
Flood	25	46	18	0.03	-0.08
Tornado	23	24	17	0.22	0.17
Hurricane	13	17	12	0.53**	0.85**
Earthquake	16	2	16	0.38*	0.16
Landslide	22	3	1	-0.12	-0.03

* $p < .05$; ** $p < .01$

Table 4: Recommendations for SEMA Hazard Analysis Websites

1. Recognize that your website is an authoritative source, which makes the information especially credible.
2. Recognize that a website is a communications channel that transmits information directly to the public without passing through the usual print newspapers, magazines) and electronic (television and radio) newsmedia. This reduces the potential for message distortion, but also requires a high standard of clarity and organization by the SEMA.
3. Address all of the hazards to which your state is vulnerable, but also provide information about the likelihood of major events so that people can judge which ones to set as the greatest priority.
4. Provide non-technical explanations of hazard origination (e.g., how hurricanes form) and dynamics (wind, rain, and surge behavior) because such information helps people to understand what will happen and why it will happen.
5. Provide information about hazard impacts. These include the speed of onset, scope and duration of impact, and the magnitude of different types of impacts such as casualties (deaths and injuries), property damage, and economic impacts (disruption to industrial, commercial, agricultural, and governmental activity).
6. Provide information that *personalizes* the potential consequences for the viewers. These include the cumulative probability of being affected during the different periods of time that a person would live in a risk area (e.g., 10, 20, and 30 year intervals).
7. Provide information about hazard adjustments—actions that people can take to protect persons and property from the hazard. Explain how effective these actions are in protecting persons and property, if useful they are for other purposes, how much they cost, what knowledge, skills, tools, and other resources they require. Describe the specific steps required to perform any unfamiliar actions.
8. Provide a site index or table of contents to help to find the needed information within your website.
9. Provide a variety of emergency-related information—situation reports, training and exercise schedules, and links to local, state and federal emergency-related organizations.
10. Organize the links to other sites by referring the user to the page that addresses a specific topic, not the organization's home page. In particular, nonspecific links to FEMA and Red

Cross home pages are problematic because those who do not already know what hazards they are vulnerable to will not easily find out at those locations.

11. Use letters in a suitable font size and simple color so that the information is easy to read.
12. Provide just enough figures and pictures to explain the text and maintain interest, but avoid redundant pictures.
13. Design your website to be compliant with the Americans with Disabilities Act which requires, among things, that pictures and graphs be described in words and that your site be navigable without a mouse.
14. Make it easy for viewers to download information by attaching documents in PDF format or word processor format.
15. Have contact lists to provide the postal and e-mail addresses, telephone numbers, and fax numbers, of persons in charge.
16. Provide search engine for a rapid search for documents in the SEMA's websites.