A Collaborative User-Producer Assessment of Earthquake-Response Products

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Acronyms and Abbreviations Used

ANSS	Advanced National Seismic System
EHP	Earthquake Hazard Program
ENS	Earthquake Notification System
EMD	Emergency Management Division
EOC	Emergency Operations Center
FEMA	Federal Emergency Management Agency
GIS	Geographic Information System
PAGER	Prompt Assessment for Global Earthquake Response
REOC	Regional Emergency Operation Center
SME	Subject-matter expert
USGS	U.S. Geological Survey

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By Joan Gomberg and Allen Jakobitz

Abstract

The U.S. Geological Survey (USGS) and the Washington State Emergency Management Division assessed how well USGS earthquake-response products met the needs of emergency managers at county and local levels. Focus-group responses guided development of new products for testing in a regional-scale earthquake exercise. The assessment showed that (1) emergency responders consider most USGS products unnecessary after the first few postearthquake hours because the products are predictors, and responders are quickly immersed in reality; (2) during crises a significant fraction of personnel engaged in emergency response are drawn from many sectors, increasing the breadth of education well beyond emergency management agencies; (3) many emergency personnel do not use maps; and (4) information exchange, archiving, and analyses involve mechanisms and technical capabilities that vary among agencies, so widely used products must be technically versatile and easy to use.

Introduction

The Earthquake Hazard Program (EHP) of the U.S. Geological Survey (USGS) has the statutory responsibility under Public Law 108-360 within the National Earthquake Hazards Reduction Program to "operate a national seismic system" and "work with officials of State and local governments to ensure that they are knowledgeable about the specific seismic risks in their areas." As is sometimes the case with agencies or individuals focused on addressing immediate societal needs, EHP products have not always been developed with the goal of addressing verified needs. Moreover, needs and capabilities may change with time, warranting updates of assessments of products' efficacies. Table 1 lists and describes the current EHP products meant to fulfill the USGS's statutory responsibilities by providing the information needed for effective earthquake response.

A key user group of EHP products is the emergency-management community at State and local levels. To date, the EHP has not yet assessed or systematically verified the fulfillment of user needs by directly polling these intended beneficiaries. Several examples highlight the importance of this direct polling. Wald and others (2011) note that alerting systems for other types of disasters were evaluated and found ineffective because they did not meet user needs to assess the likely impacts of the disaster; for example, alerting systems for pandemic diseases by World Health Organization and for terrorism by U.S. Department of Homeland Security were found ineffective. In their study of State and local emergency response to hurricanes, Lindell and others (2007) note the importance of developing response tools grounded in a clear understanding of responders' needs. They state that "the development of these decision support systems will provide a critical foundation for evacuation decisions, but the development of such tools must be guided by a better understanding of the context in which these decisions are made at the state and local levels." Herein, we describe results of the project

Table 1. Earthquake Hazards Program response products.

Product and URL (additional information)	Description
Earthquake Notification System *https://sslearthquake.usgs.gov/ens*	Sends automated, customizable notifications of earthquakes through email, pager, or cell phone
ShakeMap *http://earthquake.usgs.gov/earthquakes/shakemap/*	Automatically generated maps displaying instrumentally measured shaking intensities
Did You Feel It? *http://earthquake.usgs.gov/earthquakes/dyfi/*	Map of earthquake effects derived from citizen input via online Web forms
PAGER *http://earthquake.usgs.gov/research/pager/*	Prompt Assessment of Global Earthquakes for Response rapidly compares the population exposed to various shaking intensities to estimate likely fatalities and economic losses
Realtime Earthquake Map *http://earthquake.usgs.gov/earthquakes/map/*	Automatic maps and event information displayed online within minutes after earthquakes worldwide
CISN Display *http://www.cisn.org/software/cisndisplay.html*	Stand-alone application that graphically alerts users, in near real-time, of earthquakes and related hazards information.
ShakeCast *http://earthquake.usgs.gov/research/software/shakecast/*	An application for automated delivery of ShakeMaps and probable damage to specific user-selected facilities.

in which we sought to learn directly from emergency managers at the State, County, City and other local levels about their needs and how EHP products addressed those needs.

Anecdotal evidence from EHP personnel in other regions and the institutions that make up the USGS-managed Advanced National Seismic System (ANSS), the umbrella structure for earthquake monitoring in the United States, suggests that emergency management departments' use of EHP products ranges from significant use to complete unawareness. Some of this evidence comes from USGS personnel serving as observers during earthquake exercises or from their direct conversations with emergency managers. A published report about the 2008 Great Southern California ShakeOut earthquake drill describes new EHP products generated specifically for the exercise (Jones and Benthien, 2011), but it makes no mention of existing EHP notification or response products that would be used in a real earthquake (table 1). The experience of a USGS earthquake subject-matter expert (SME) in southern California at the Regional Emergency Operation Center (REOC) at Los Alamitos, California, during the exercise corroborates this observation (K. Hudnut, oral commun., 2011). The SME noted that while a USGS ShakeMap was displayed in the background, it was not being actively used by emergency managers or the Geographic Information System (GIS) team. A similar experience was noted during the 2011 National-level exercise at the Federal Emergency Management Agency (FEMA) Region VI Regional Response Coordination Center in Denton, Texas, by the same USGS SME, although the GIS team tried to import and use the ShakeMap data. USGS personnel in the Pacific Northwest have observed and participated in earthquake exercises conducted locally by emergency management departments. Those experiences seemed to show that, despite having provided exercise versions of products, even the technically sophisticated departments did not use them.

This study attempts to answer the question "what is needed to improve usage of EHP products?" The Puget Sound region-wide 2012 Evergreen Earthquake Exercise Series presented an opportunity to address this question, to learn directly from State, County and local-level emergency managers and to test some new products developed collaboratively with guidance from emergency managers. The Evergreen Exercise focused on coordination among FEMA, the Washington State EMD and their State agency liaisons, seven Puget Sound-area County departments of emergency management and their local constituents. Results of our assessments will form the basis of recommendations for changes to EHP products that will enhance the effectiveness of both the EHP and emergency managers.

A goal of the project was to test the hypothesis that activities and products developed collaboratively, by users and providers, will more effectively meet user needs. Experiences of the U.S. Army Corps of Engineers provide support for this approach and are summarized in a paper describing changes in how the Corps addresses its mandate to facilitate disaster response and recovery (Hecker and others, 2000). For example, the report notes that "the Corps has learned the significant need for and value of 'peacetime' [that is, before a crisis] planning and partnering with our counterpart State and local agencies." Our project team members include both providers from the USGS EHP office in the Pacific Northwest and users from the EMD.

In the first project phase we attempted to directly assess the awareness and usage of EHP products by emergency managers by hosting focus-group listening sessions (Peek and Fothergill, 2009, and references therein). We used this information to identify and develop several new products for the Evergreen Exercise that we also attempted to evaluate during the exercise. These were developed and implemented collaboratively, by the USGS and Washington State EMD (referred to as USGS-EMD products). The final results of this project are being communicated to broader communities, within the USGS, and among emergency managers, with the goal of affecting long-lasting change.

The Assessment Phase

Focus-Group Goals and Format

The use of focus groups for gathering input is well established (Peek and Fothergill 2009). The goal of the focus group sessions we conducted was to listen and learn from county emergency managers and their constituents. Participants included all of the counties playing in the Evergreen Exercise, State agency liaisons (employees responsible for emergency preparedness and response in the Washington State Departments of Corrections, Commerce, Transportation, General Administration, Labor and Industries, and the Red Cross), and several large private companies (Liberty Mutual Insurance and T-Mobile). One county chose to respond with only written answers to the discussion questions we provided. Each session was initiated with a request to the director or another employee of the county department of emergency management, who assumed responsibility for recruiting participants. In this way participants were more likely to be those with strong connections to the business of postearthquake emergency response than if we had recruited participants ourselves (Peek and Fothergill, 2009). Sessions were held at county emergency management facilities and involved between 3 participants (for the private-sector session) and 28 in the largest group and included men and women. Participants included County, City, and local (hospital consortia, private company, school system, and others) emergency management agency employees, firemen and police, public utility workers, emergency planners for medical facilities and schools, and others. Most participants had experience responding to a few small earthquakes and perhaps half the participants responded to the 2001 *M*6.8 Nisqually earthquake, which was the most recent damaging earthquake to affect the region. We provided a list of warm-up questions that had been circulated to all invitees before the group meeting and also used to guide discussion during each session. Both authors led most of the sessions, although in a few cases just one of us moderated. Each session lasted approximately 90 minutes, and participants generally were engaged and expressive. We took written notes during each session, summarized them, requested corrections from session participants, and shared final drafts with participants from all the sessions.

Focus group questions were organized in the time sequence of a real earthquake occurrence, from notification, gathering situational awareness, and distributing information. This organization seemed like the most logical way to help participants organize their thoughts. We began with questions about notification that an earthquake had occurred. Examples of the most general questions include, "How would you be notified that an earthquake has happened? What information do you need to be able to respond?" Then we asked about information gathering such as, "How is information communicated, integrated, tracked, archived, and displayed? How do you assess what and where the impacts are most significant and then prioritize those needs?" These were followed by questions about distribution of information, for example, to whom and how? Finally, some general questions were posed such as, "What did your agency glean from the 2001 *M*6.8 Nisqually earthquake? What additional training would improve your response to earthquakes?" We concluded with an open discussion with participants addressing any comments or questions they had about products and services currently provided by the Washington EMD and USGS.

We did not follow a strict protocol for gathering information and quantifying responses. While the same questions were used to guide each session, we intentionally allowed discussions to be participant-driven, so the level of detail and topics covered varied among the groups. The level of detail recorded also varied both within individual sessions and among them. For these reasons, we did not perform any formal analyses on the information gathered at the focus group sessions (such as those suggested in Merton 1987; Peek and Fothergill, 2009), and do not convey results quantitatively (for example, in terms of percentages of responses). Instead our inferences reflect our own qualitative assessments of common themes and significant lessons drawn from focus group input.

Focus Group Lessons

Users' Geographic Scope

Earthquake-hazard products must address a wide range of needs and capabilities. Needs and opinions expressed in focus groups varied significantly among the sessions, reflecting the characteristics of the responding county. The smaller, more geographically remote, and less resource-rich counties seemed more satisfied with the status quo and more focused exclusively on their own jurisdictions. At the other extreme, the two private companies' interest was more focused on a single institution (their own facilities and operations) than the diversity of groups and needs attended to by emergency managers; however, the companies' interests were global in geographic extent because of the distribution of their facilities and operations throughout the world.

Notification

Participants indicated five different methods of notification that an earthquake was occurring. (1) Feeling the ground shake. In many cases this was the only method of notification deemed necessary, justified by the assertion that earthquakes too small or distant to be felt would not require immediate attention. (2) Receipt of reports of shaking from 911 call centers. (3) Electronic notifications, mostly from the USGS's Earthquake Notification System (ENS; table 1). (4) Social media (particularly Twitter) were considered reliable and useful. Twitter users believed erroneous messages were naturally discovered and corrections dispensed, and notification tweets often arrived before television or radio broadcasts. No participants mentioned using the EHP Twitter notification service. (5) Smart-phone applications. With respect to technology, all participants told us that emergency notifications increasingly are received via cell- and smartphones and they encouraged tailoring and delivering earthquake information via these devices.

Situational Awareness

Situational awareness, "the engine that drives decision making" (Endsley and others, 2003), is key to effective emergency response (McManus and others, 2008). Situational awareness products need to convey information about the impacts of an earthquake in nontechnical terms, at spatial scales relevant to county and local-level response, and be delivered simply in standard formats. For emergency managers and the private companies, awareness following earthquakes requires tangible metrics of impact (Wald and others, 2011) conveyed in nontechnical language and graphics. One response within the EHP to the users' need for situational awareness has been the development of an Earthquake Impact Scale (Wald and others, 2011) and the PAGER (Prompt Assessment for Global Earthquake Response) product for M>5.5 earthquakes (Earle and others, 2009), which provides estimates of the economic loss, fatalities, and population exposed to various potential damage levels. However, participants noted that the scale of PAGER information is too large to be useful at the county and local level, particularly for smaller earthquakes. Other available products meant to convey impact and distributed rapidly include USGS ShakeMap, the Did You Feel It? mapping tool, and ShakeCast (see table 1). Many counties and both companies we interviewed were unaware even of the existence of these products (particularly ShakeCast). With regard to the products and information they were aware of and did use, such as the USGS Web site, users noted that they often included overly technical, extraneous information. A suggested remedy was the availability of two sets of products, one designed for the general public and the other for more technical audiences such as engineers and scientists.

Key earthquake parameters deemed essential for making response decisions include earthquake magnitude and epicenter given as the distance in miles relative to a known geographic landmark. Many people also wanted to know the earthquake depth, understanding that it might affect the severity of the effects. The current EHP products provide these parameters. Everyone felt knowledge of the level of impact of the earthquake in the geographical area where his or her particular facilities were located also was considered key. Many of the EHP products are meant to facilitate situational awareness (for example, ShakeMap, Did You Feel It?, PAGER, ShakeCast; see table 1). Participants noted that current EHP products did not always convey an easily understood picture of the impacts of earthquakes.

Focus-group participants revealed that situational awareness primarily comes from personal reports received from 911 call centers, fire and police departments, and what responders often call "windshield surveys," in which they gather damage information by driving through impacted areas and report their observations back to a response center. Widely used situational-awareness information sources include National Oceanic and Atmospheric Administration weather radios, local and regional media, and various Web sites. Communication of situational-awareness information from the field to emergency operations centers appears to rely heavily on telephone calls. A number of agencies are developing mobile applications for acquisition and delivery of field information and for gathering crowd-sourced observations (from the general public using electronic media). Amateur radio operators provide an important backup means of communications in many communities.

Emergency managers placed a high value on information verified by human observation to develop postearthquake situational awareness. They rely on on-site first-hand assessment of impacts when making decisions about if and how to respond. This was also true for the two companies, but to a lesser degree. The need for eyewitness verification differs from much of the scientific work underlying the understanding of earthquakes, which relies on inferences derived from instrumental measurements made remotely. Although derived from in-place measurements of actual ground shaking, map products like ShakeMap or Did You Feel It? were sometimes only considered overviews or corroboration of the event and its effects gleaned from other sources. The products are not used as a primary basis for decision-making, perhaps because the scale of USGS products is too large for use at the local level, because of challenges integrating the products with familiar mapping and awareness tools, or because the perception that a picture relying on a model or interpolation may not be sufficiently accurate. (The choice of scale in USGS earthquake-response products has been made based somewhat on technical limitations on the spatial resolution of the quantities being mapped, and do meet the needs of users other than county and local emergency managers—for example, agencies involved with national-scale response to major earthquakes globally.) Many responders were simply unaware that these map products existed. We suggest that a more formalized strategy to raising awareness about EHP products than currently exists would improve their usage significantly.

No single mechanism of compiling, storing, and conveying information to those needing it could be identified as universally used. Most institutions use commercial electronic database and mapping systems, with some using these exclusively. Others have built in-house systems to organize, share and display observations using commercial applications like Microsoft's Streets and Trips® and SharePoint®, Google's GoogleEarth™, or ESRI's ArcGIS™. WebEOC, a real-time Web-enabled crisis information management system developed commercially by ESi, is meant to be an official link among public sector emergency managers in Washington State (see *http://www.esi911.com/esi*). While used by many agencies, it always was just one of multiple communication tools. A commonly expressed desire was for a centralized, one-stop shop for all types of disaster information (like the Department of Homeland Security's Virtual USA initiative; see *http://www.firstresponder.gov/Pages/VirtualUSA.aspx*), because the abundance of Web sites and other individual sources of information unique to specific types of emergencies often were overwhelming.

Perhaps the most unanimous agreement about any issue raised pertained to the utility of receiving estimates of the probability of aftershocks. Emergency managers all stated that even if uncertain, probabilities would be useful for prioritizing and scheduling recovery activities. For example, after the Northridge earthquake in 1994, aftershock forecasts were used to make strategic decisions about replacement or de-commissioning of insulators and other spare parts at certain power substations. Emergency managers also noted that the general public would like to know about aftershock probabilities.

The Testing Phase

Exercise-Version Products

In the first phase of our project, we learned that some of the EHP products have not met some important needs. Guided by the insights gleaned from these sessions, the project team identified and developed products meant to address some of the unmet needs. We attempted to test their effectiveness during the Evergreen Exercise in June 2012. Herein we describe these new USGS-EMD products and the lessons learned during the Evergreen Exercise.

Working together as an USGS-EMD team on the focus-group phase of the project permitted us to reach out to and learn from current and potential users in more efficient and informative ways than if either group had worked alone. For example, EMD personnel have much greater awareness than USGS personnel of the potential users in the emergency management communities, particularly at the local level. During product development, USGS and EMD project members repeatedly exchanged drafts and changes to materials, which readily revealed misconceptions about what constitutes understandable language and interesting or useful information, making it easy to identify specific paths to improve clarity.

In the following list we summarize the needs identified in the assessment phase and the products designed specifically for use and efficacy testing during the Evergreen Exercise.

- Simpler messaging and explanations are needed by some users, and this may be achieved by developing two styles of some products, one designed for nontechnical users and the other tailored for engineers and scientists. Accordingly, we developed a new, shorter (single-page) summary Web page written in more colloquial language about the ShakeMaps of the scenarios that guided the exercise (fig. 1). This Web page described what ShakeMaps are, the various types of ShakeMaps available, and links to tools for downloading them for import into other systems and to other more detailed or technical information.

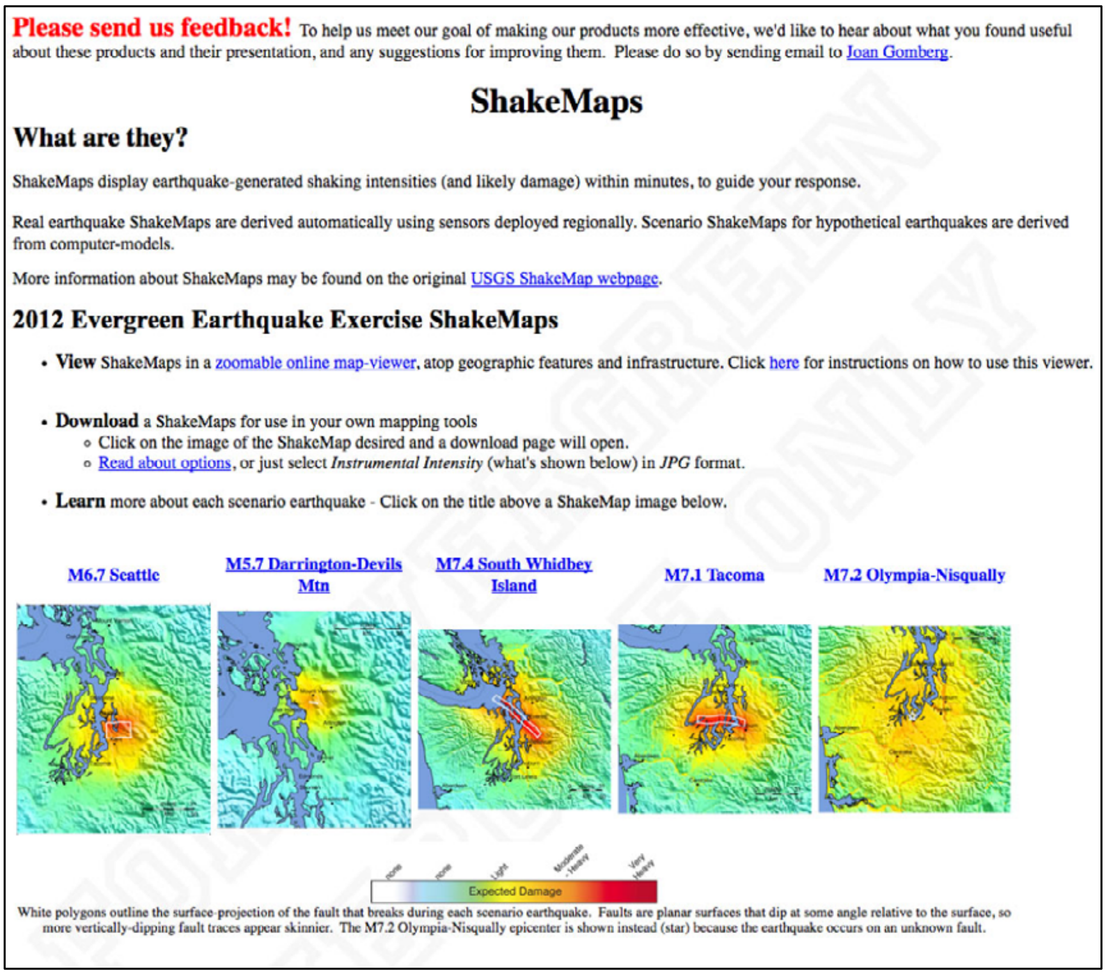

Figure 1. Image showing ShakeMap Web page for the Evergreen Exercise. The Web page was intended to provide exercise participants with a basic understanding of the ShakeMaps used to design the exercise scenario and with links to a ShakeMap map viewer (fig. 2) and to more detailed or technical information.

- Maps need to be at scales useful for county-level response and have layers of familiar geographic features and infrastructure relevant to response. We developed an expandable online map viewer, accessed using standard Web browsers (fig. 2). This viewer was built around ESRI's ArcGIS™ Web map service, and allowed users to superpose transparent ShakeMaps on a variety of base maps as well as layers containing various types of infrastructure. In addition, users could add facilities impacted by the scenario earthquakes to the maps they were viewing.

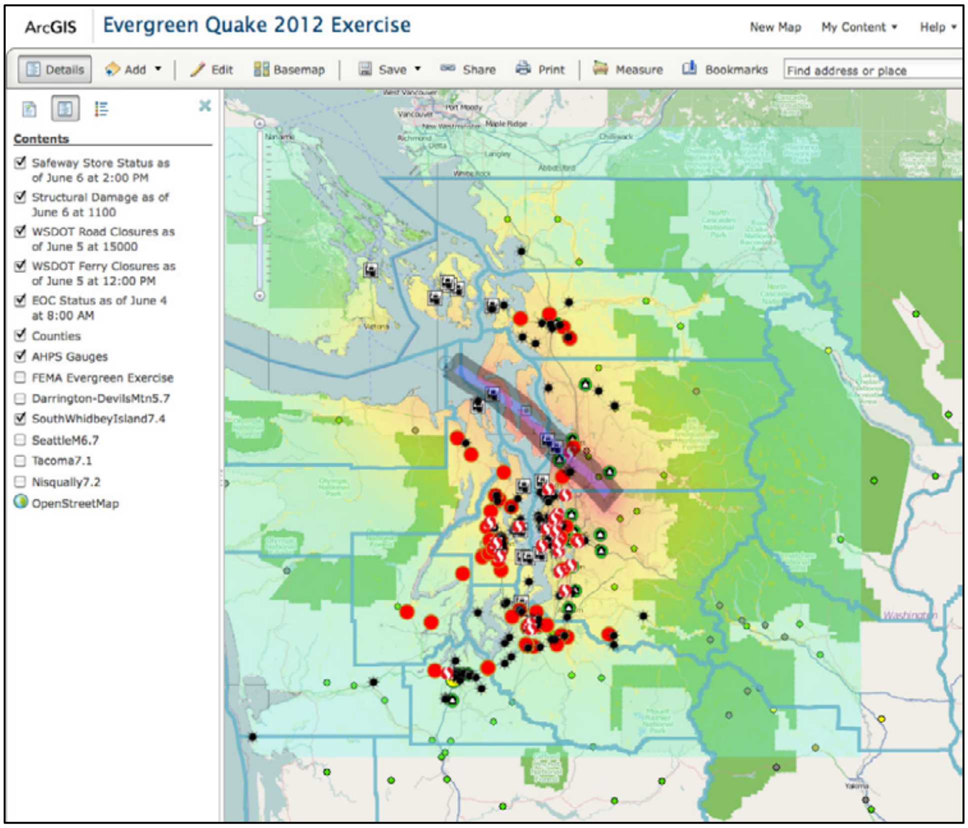

Figure 2. Image showing an example view of the online, zoomable ShakeMap interface. This example shows the ShakeMap for the South Whidbey Island scenario earthquake (yellow to red shading) as a transparent layer on a base map with county boundaries, roads, parks, and other geographic features. Locations of closures, damaged structures, and operating facilities resulting from the scenario earthquake are shown by the various symbols. The rectangle in the center of the ShakeMap outlines the fault that broke during the earthquake.

- The tangible impacts of an earthquake must be conveyed more simply and succinctly, employing a scale useful for decision-making at the regional and local levels. We produced a prototype Earthquake Impact Web page, which is a simplified, higher-resolution version of the USGS's PAGER product (for example, showing losses by city and county; fig. 3). The ShakeMap serves as input to a rapidly executed economic loss estimation tool. The one-page Earthquake Impact document conveys impacts in terms of estimated population exposure to various shaking levels and dollar losses to specific counties and cities.

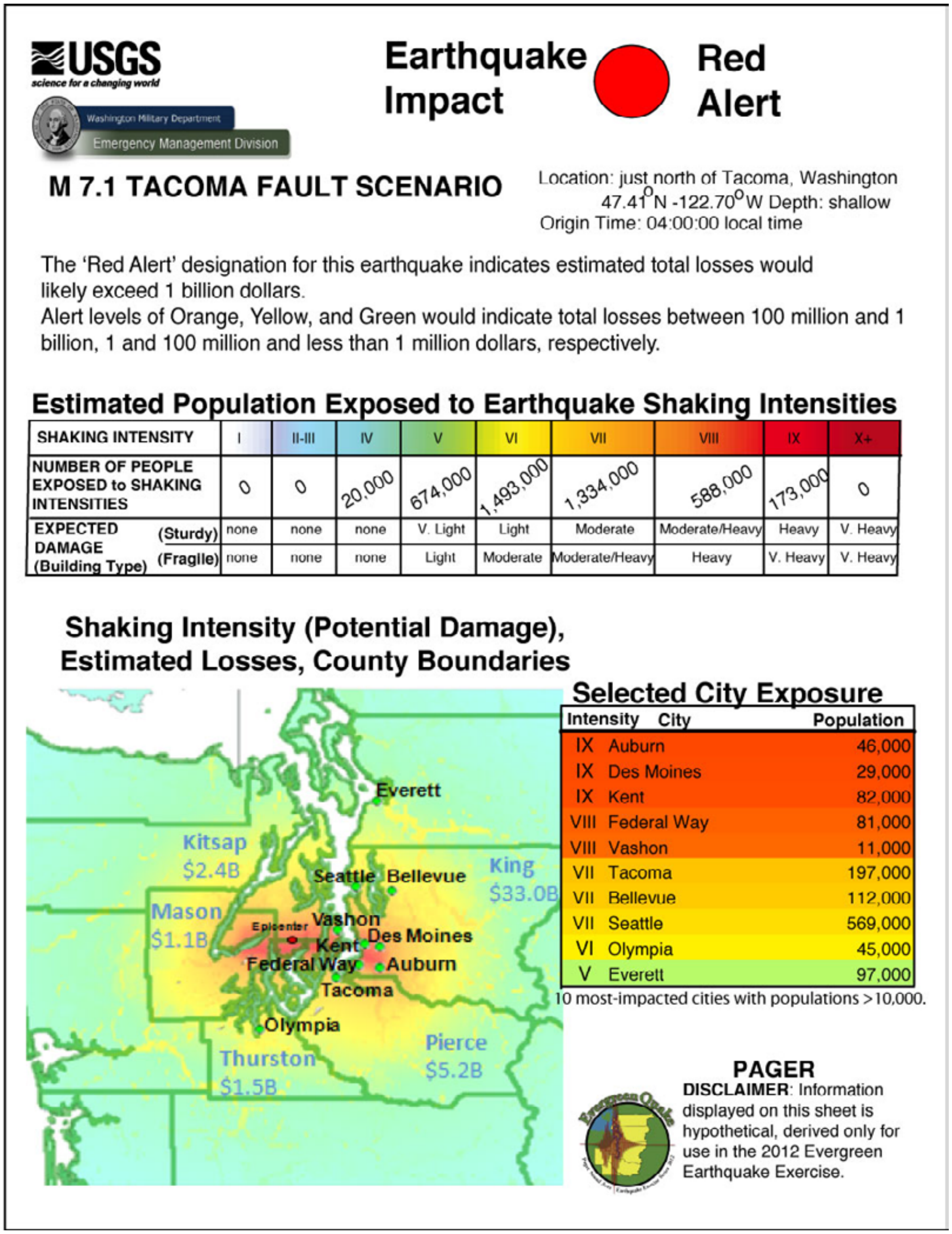

Figure 3. Image showing an example view of the Earthquake Impact Web page. The prototype Web page is modeled after the PAGER product (prompt assessment for global earthquake response) by the U.S. Geological Survey, but it is simplified and at a more regional scale.

- Increased awareness of which products require active repeated educational outreach to intended users. While face-to-face meetings were considered useful, tutorials and seminars delivered electronically were considered most desirable because they required no travel and could be viewed at users' convenience. Several months prior to the Evergreen Exercise we described EHP products in an hour-long webinar titled "A Practical Guide to Pacific Northwest Earthquakes," which was attended by about 130 exercise participants. The material presented was developed into an online tutorial for individuals, viewable with any Web browser (fig. 4). The tutorial and the products described above were demonstrated at the final exercise planning meeting and advertised by sending emails to all county Emergency Operations Center (EOC) managers and via postings on the official exercise Web site and in the exercise training guide.

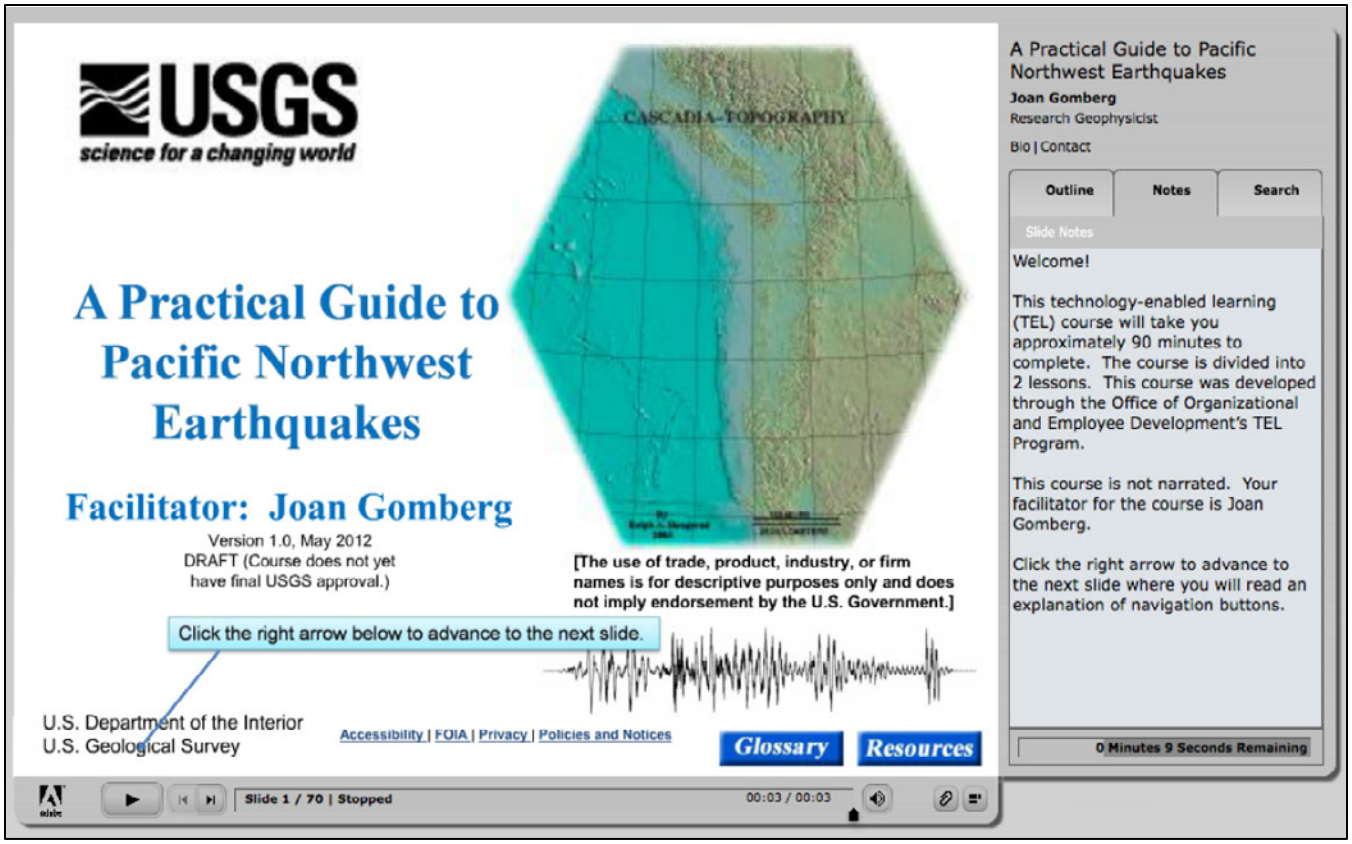

Figure 4. Screenshot of the first page of the online tutorial, "A Practical Guide to Earthquakes." This tutorial was made available to all Evergreen Exercise participants prior to the exercise, with one of the two lessons dedicated to information about EHP products. It can be viewed using any standard Web browser.

Testing During the Evergreen Exercise

To measure the effectiveness of our efforts to market our new USGS-EMD and existing EHP products, we posted observers at all of the participating county EOCs, at the Washington State EOC, and at FEMA Region X's EOC during one of the two exercise days. We requested that these observers note if and which of the products were used, and what other tools and mechanisms of information exchange were most commonly employed and how effective they were. Observers were geologists or seismologists employed by the USGS or Pacific Northwest Seismic Network at the University of Washington. We summarize observers' common observations and inferences below.

Observer reports all led to the same general conclusion: none of the USGS-EMD or EHP products were used, and in most cases, the products were completely ignored. We believe that the lack of use of the USGS-EMD and EHP products was their incompatibility with the design of the Evergreen Exercise, rather than problems with the products themselves. The first flaw in the exercise for testing purposes turned out to be the fact that the scenario started one day after the hypothetical earthquakes occurred. The exercise scenario was built around the simultaneous occurrence of five major earthquakes in the Puget Sound region, and exercise participants felt that after one day, information about the causes of the disaster was irrelevant to their task of recovery—sufficient situational awareness had already been gleaned such that products like ShakeMap were no longer useful. In other words, a clear inference is that the USGS-EMD and EHP products are considered useful only in the very first hours after an earthquake. The second flaw was the lack of aftershocks in the exercise scenario, which, together with the late start, effectively eliminated all perceived need for earthquake information. According to the six observers, in only two EOCs were any questions about the earthquakes' causes asked. Press releases were issued in most of the EOCs, but other than the first ones announcing the occurrence of the disasters, none contained any mention of earthquakes or connections between earthquakes and their impacts.

A third lesson pertains to awareness of USGS-EMD and EHP products and education about them. Most of the personnel staffing the EOCs were there on temporary assignment as liaisons from other widely varied entities. Some were serving at an EOC for the first time. How do we effectively educate such a diversity of transient participants? In the largest counties and at the Washington State EOCs, liaisons receive regular training between disasters, and these trainings may provide venues for product marketing. In addition, EOC managers educated about products may guide even temporary workers toward using them during real earthquake disasters.

Several other common threads were clear in observers' reports. Observers all expressed surprise at the lack of reliance on maps. Instead, information was conveyed via spreadsheets, lists and other nongraphical means. In some EOCs maps showing locations of impacted infrastructure were displayed, but observer perception was that most EOC staff were not using them to do their work. A lesson for product developers may be to present information in a variety of formats and (or) to make maps easier to generate, display, and use. Another common thread among observer reports was the wide variety of procedures and methods used for information exchange, archiving, and analysis. Those methods involving computer and networking technologies presented significant challenges to smooth operations at most EOCs. While the State EMD serves as the central clearing house for operations and situational awareness, communications to and from the State EMD were in many cases infrequent and not easily executed. This lack of uniformity in approach and technical capabilities might suggest that to be widely useful, products must require minimal user technical expertise.

Conclusions

The USGS and Washington State EMD conducted a project to learn about the needs of county- and local-level emergency managers and how well USGS Earthquake Hazards Program (EHP) earthquake-response products met their needs. Focus group meetings held with emergency managers and their constituents in seven counties, with other State agencies' emergency managers, and with two private companies, revealed that earthquake-response products have not met some important needs of emergency managers at the county and local levels. Particular reasons for this include: (1) many emergency managers and their constituents are unaware of most earthquake products; (2) the scale of map products is not suitable to local needs; (3) products need to convey impact on infrastructure and social systems more tangibly and clearly; (4) everyday language needs to be used, and technical information provided only when necessary; (5) emergency managers' confidence in instrumental measurements needs to be raised to the same level as that which they have in eyewitness observations.

New prototype products were developed by the USGS-EMD team that attempted to address the needs revealed in the focus groups. These new products were explained and marketed to participants in the regional 2012 Evergreen Earthquake Exercise, where they were to be tested by observing the exercise at the participating Emergency Operation Centers. The fact that the exercise started 24 hours after the hypothetical earthquakes and included no aftershocks made it poorly suited for the purposes of testing USGS-EMD or EHP products, but valuable lessons were learned nonetheless. (Future testing, modification, or adoption of the new products has not been determined.) One clear lesson was that emergency responders rely heavily on ground-truthed information about impacts rather than USGS-EMD and EHP products, even during the first few hours following an earthquake. Another lesson pertained to education and marketing of products, a process that needs to extend beyond EMDs because during crises a significant fraction of personnel involved in the response come from many other sectors of the community. Fortunately, many county EMDs have established networks with their communities and working methods used to reach community members, so piggybacking on these can be an effective means of reaching a broad constituency. A surprising lesson was that information conveyed via formats other than maps should be considered, as many emergency personnel do not use maps. Finally, information exchange, archiving, and analysis involve a wide range of mechanisms and technical capabilities that vary significantly from one emergency management agency to another, implying that widely used products must be easily accessed and employed.

Acknowledgments

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