Does Information Released by Current Web-Based Earthquake Monitoring System Provide Benefits for Mitigation?

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Abstract

To determine if the present system can provide enough response time for mitigation and immediate rescue, we designed a prospective study to investigate the reliability of the internet and the timing of earthquake information release from the Central Weather Bureau from November 2001 to April 2002. There were 171 earthquakes with the magnitude greater than 3.0 on the Richter scale. In the prospectively recorded 82 events, the "response time" (calculated as the differences of the time that we received the information and the time of posting) was 5.2$\pm$1.5 min. The unavailability rate was thus about 12.2%. One episode was the magnitude of 5.0, two episodes 4.0 and the remaining 3.0. The web could not be assessed in all the events greater than 4.0 (3/3) and in one episode of 3.0 (1/6). In conclusion, we suggest that the seismic center keep in good condition with the internet system and power company and be engaged in the establishment of the alternative system and the autonomic posting system. *(Ann. Disaster Med 2002;1:36-42)*

Key words: Earthquake; Mitigation; Warning system

Introduction

Taiwan is located between the Philippines and the Euro-Asia tectonic plates, which may be the most active seismic belt of the Pacific Rim in Asia, and has been impacted by frequent earthquakes.[1] According to the past epidemiological data, the average incidences of earthquake are more than two thousands events every year.[2] More than two hundreds among them are perceptible. It has suffered severe losses in the past due to these disasters. The general public has long been very concerned about natural disaster events, and the government has taken this matter seriously. Since the most powerful earthquake hit Taiwan on September 21 1999, the National Center for Research on Earthquake Engineering in Taiwan has tried every effort in developing methodologies for hazards

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potential analysis and building up disaster risk and damage assessment models. However, the earthquake early warning system has still depended upon mainly the web-based information posted from the Central Weather Bureau at present.[2] The reliability of this system relies on the stability of internet system during devastating earthquake and also the timing of information provided by the Bureau. We then designed the following prospective study to investigate the reliability of the internet and the timing of earthquake information release during the last six months to determine if the present system can provide enough response time for mitigation and immediate rescue.

Methods

Study protocol

The details of each perceptive earthquake were released from the website of Central Weather Bureau (http://www.cwb.gov.tw/V3.0/index.htm). We prospectively monitored the availability of real-time reports from the above website from November 2001 to April 30 2002. The differences of the time that we detected the information and the time of posting (or so-called response time) were calculated and recorded. In addition, the factors that interfered with information perception were also detailed during each event.

Analysis of seismological impact

We also assessed the above website to collect the seismological data (including all earthquakes with the magnitude greater than 3.0 on the Richter scale) retrospectively to analyze the possible impact of the magnitude on the availability of the real-time release. Concomitant dysfunctions of power or internet system were also recorded after contacting with the related companies.

Statistics

We entered all transcripts into Microsoft Excel 2000, a software package used to manage qualitative data. This system allows descriptive statistical analysis.

Results

Availability of real-time information

There were one hundred and seventy one earthquakes with the magnitude greater than 3.0 on the Richter scale during the study period. We have prospectively recorded 82 events. The "response time" (calculated as the definition mentioned in the "method") was 5.2 ± 1.5 min in average after excluding the ten events that we could not assess the website. The unavailability rate was thus about 12.2%.

Impact of the earthquakes on information release

Among one hundred and seventy one earthquakes with the magnitude greater than 3.0 on the Richter scale during the study period, nine of them hit Taipei city with the magnitude greater than 3.0. In detail, one episode was the magnitude of 5.0, two episodes 4.0 and the remaining 3.0. The web could not be assessed in all the events greater than 4.0 (3/3) and in one episode of 3.0 (1/6). In contrast, we still cannot approach the web in another 6 episodes even the magnitudes of earthquake in Taipei City were less than 3.0.

Further analysis revealed that the overall internet failure accounted for 100% (1/1) of the episodes with the magnitude of 5.0., whereas the website dysfunction (that is, we could assess other website at the meantime) comprised 100% (9/9) of those with magnitudes less than 5.0. There is no power failure in these events.

Discussion

There have been many advances in seismological techniques in recent decades.[3,4] To rapidly and precisely estimate an earthquake epicentre, depth and magnitude, data from a network of telemetered seismographs is required. The more recordings used, the more precise the location. For most reliable estimates, there should be a telemetered recorder near to the epicentre.[5,6] The seismologist from the information provided by the pager system can calculate a preliminary location. Additional data can be down loaded from other dial-up seismographs. In the future it is planned to have a real-time earthquake location system with a preliminary earthquake location and magnitude sent directly to the pager. But how to alarm general population still remains an issue to be investigated.

Accordingly, a good earthquake preparation, alarm and response system should provide the benefits of the service for owners of major structures and emergency organizations, risk management for lifelines and other assets, asset vulnerability assessment, timely provision of alarms, damage scenario generation, and emergency simulation and training.[3] After an earthquake the first task for a seismologist is usually to determine the longitude, latitude, depth and magnitude of the earthquake. This is not necessarily the most useful information for people responsible for managing large assets or emergency services. Of more value to such authorities would be answers to the questions that what the likely effects of this earthquake are and what course of action should be undertaken. The seismological center should also provide the information about the earthquake and the general outcomes of the earthquake. This includes descriptions of the expected effects likely to be observed in towns near the epicenter. The second information contains descriptions, in order of importance, of the effects of the earthquake on a predetermined list of assets for which the authority is responsible. And the task list contains inspection and mitigation measures to be carried out by staff on site, as well as communication tasks such as informing management, public relations or emergency services.

The content of information may be modified according to the demands of the public and updated under the efforts of working groups. However, the availability of the immediate seismological data may be the first priority. In this study, we find that the web-based information release may be not so reliable in earthquake alarming, especially in consideration of the golden response time being only 90 seconds. Although the Central Weather Bureau has had excellent seismic monitoring system and strong motion instruction and collected many important data from previous devastating earthquakes,[7] which have been deeply appreciated by the seismologists all over the world. The benefits of mitigation have still not met at present.[8,9] Our report revealed that instabilities of internet / electrical power during earthquake and the timing of information release may be the big two problems.

The reliability and time delays within the system are critical factors for the usefulness of the system in an emergency.[3,4,10] Seismograph networks are inherently reliable because the field seismographs usually operate independently of one another, so a degree of redundancy is usually built into the network. In addition, because field seismographs usually do not use mains power, this level of reliability will not change if there is a major earthquake. An uninterruptible power supply in the seismology lab will allow the location computer and damage scenario program to be run even if there is a power failure. In the event of a large, damaging earthquake the most likely sources of failure within the system are currently the telephone links between the remote recorders and the laboratory, and the communication links between the laboratory and the seismologist and between the seismologist and the authorities control center. Telemetry failure of seismic data can be minimized by using a combination of telephone links and radio links, or by duplication of critical sections of the system. To minimize other communication failures, a range of alternative communication channels can be provided. Satellite based mobile telephone systems will significantly improve reliability.[4] Another way of improving reliability is by using a network of alarm systems. If neighboring seismograph networks actively co-operate, then reduced precision preliminary information can still be supplied in case of communications failure, perhaps associated with a large earthquake.

In conclusion, we suggest that the seismic center keep good contact with the internet system and power company. Further planning about establishment of the alternative system is highly recommended. In addition, the autonomic (instead of personal key-in) posting of the earthquake information may be the resolution of the delayed information release.

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透過現行以網路為基礎的地震監測系統來發佈訊息可以提供良好的減災準備嗎？

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摘要

為了確定即時系統是否可以提供足夠反應時間來減災和及時搶救，我們前瞻性的研究自 2001 **年** 11 **月至** 2002 **年** 4 **月期間，由中央氣象局所發佈地震訊息的時間性，及發佈時網路的可靠程度。在此期間，強度超過芮氏規模** 3.0 **的地震，共有** 171 **個。在前瞻性記錄的** 82 **個事件中，「反應時間」（依照我們收到訊息及發佈消息時間之間隔計算而得）為** 5.2 ±1.5 **分。網路接收的失敗率為** 12.2%**。在這些地震中，有一件強度為** 5.0 **級，二件強度為** 4.0 **級，其餘為** 3.0 **級左右。在所有強度超過** 4.0 **級的事件（**3/3**），以及一次強度為** 3.0 **級的事件（**1/6**）中，我們無法接收到這個網頁。因此，結論是我們建議地震中心應保持網路系統及電力系統良好的狀態，並能致力於替代系統與自動回報系統的建立。** *(Ann. Disaster Med 2002;1:36-42)*

關鍵詞：地震；減災；警告系統

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