RECENT APPLICATIONS OF THE SEISMONITOR EARTHQUAKE PREPARATION, ALARM AND RESPONSE SYSTEMS

Wayne Peck, Gary Gibson and Greg McPherson

Seismology Research Centre, RMIT University, PO Box 71, Bundoora, VIC 3083

Wayne Peck, B.Ed, AEES
Gary Gibson, B.Sc, AEES, GSA, SSA, EERI, AGU, SEG
Greg McPherson. B.App.Sci
Seismology Research Centre, RMIT, Melbourne

Wayne Peck has seven years experience in field seismology, operating seismograph networks and installation of aftershock networks. He has also been involved in a range of seismological consulting projects, particularly in earthquake hazard analysis.

SUMMARY

The Seismology Research Centre has been operating the SeisMonitor near real time earthquake alarm system for several years. This has recently been upgraded to incorporate time-stamped data obtained from seismographs using telemetry systems that insert unpredictable delays in transmission. This means that data available over the Internet can be included, either continuously or after an event has been detected. This is another step towards the concept of a near real time network of networks of seismographs.

The earthquake preparation, alarm and response system has been tested by several events over the past year, including the ML 5.0 event at Thomson Reservoir in September 1996. Experience has indicated new features of value to clients can be included in the alarm and response reports, but the total size of the reports should be limited.

KEYWORDS

Risk management, earthquake alarm, earthquake response, emergency simulation.

RECENT APPLICATIONS OF THE SEISMONITOR EARTHQUAKE PREPARATION, ALARM AND RESPONSE SYSTEMS

Wayne Peck, Gary Gibson and Greg McPherson

Seismology Research Centre, RMIT University, PO Box 71, Bundoora, VIC 3083

1. INTRODUCTION

Figure 1 gives an overview of the elements involved in the earthquake preparation, alarm and response system developed by the Seismology Research Centre[(1)]. The system combines hazard information provided by the seismologist (earthquake location, magnitude and attenuation) with vulnerability information provided by the client (asset locations, vulnerability and importance, tasks and priorities).

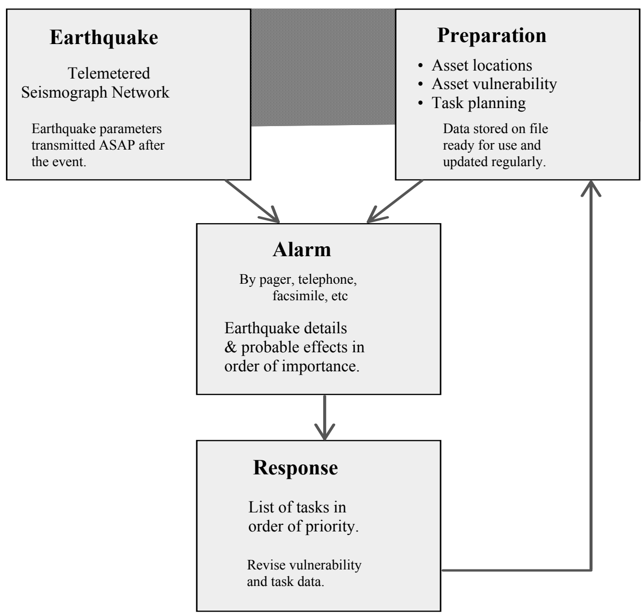

Figure 1: Overview of Elements of the system showing feedback loop.

The report generated by the system contains three sections:

The first describes the earthquake and the general outcomes of the earthquake, including descriptions of the expected effects likely to be observed in towns near the epicentre.

The second is specific to a particular authority. It contains descriptions, in order of importance, of the expected effects of the earthquake on a pre-determined list of assets for which the authority is responsible.

The final section comprises a list of tasks that should be undertaken by the staff of the authority, listed in priority order.

The alarm program calculates the modified Mercalli intensity for a given earthquake at each location in its data files. The program then looks at the tables of outcomes for each site and matches the calculated intensity to a text description for the general and specific outcomes likely to occur at that particular site for that intensity. It also matches the intensity at the site to a task data base for the authority to produce a list of tasks.

Data from the seismographs that make up the telemetered system are transmitted continuously to the SRC by radio, dedicated telephone line, or a combination of the two.

A recent development of the SeisMonitor program is the capability to incorporate time stamped data transmitted to the system via telemetry systems where the transmission time delay is unknown or unpredictable. For example seismic data available over the Internet can now be added to data recorded by a local network.

This stream of incoming data is fed to a dedicated earthquake detecting computer that digitally records any event that occurs, and alerts SRC staff of larger events via an automatic alphanumeric paging system at any time of the day or night. A rough preliminary location can be calculated by staff members from the information provided by the pager system (see below). In addition the stream of incoming data may be recorded at the centre on continuous analogue recorders so that a continuous real-time visual record of seismic activity within the network is always on hand.

For calculation of a reliable location and magnitude, it is necessary for one of the staff members with a portable computer and modem to dial into the SRC and download event data and perform a location on their portable computer. Alternatively a staff member can travel to the SRC office and locate the event. It is planned to have a real time earthquake location system automated, so that the pager system will also transmit a preliminary earthquake location and magnitude directly.

It is not expected that the earthquake alarm will be sent to users without verification by a seismologist, although some users may be interested in receiving a message to say that the alarm system has triggered on a major event and more details will be coming.

2. RECENT APPLICATIONS

1996 September 25, Thomson Reservoir, ML 5.0

An earthquake of magnitude ML 5.0 occurred at 05:49 pm on the evening of 1996 September 25 with its epicentre a few kilometres southeast of Mt Baw Baw.

The earthquake was preceded by a foreshock of magnitude ML 3.4 that occurred at the same place at 02:53 pm the same afternoon, and another magnitude ML 2.0 foreshock 63 seconds later.

The earthquake was felt in suburban Melbourne and throughout much of eastern and central Victoria. It was felt particularly strongly in the Mt Baw Baw area, where it was reported to have sounded like a large explosion, then the buildings shook strongly. Many small aftershocks occurred over the months following the earthquake, but because of the remote location few were felt.

The SeisMonitor system at the SRC laboratory triggered on both the foreshock and the mainshock. As the event happened close to normal working hours there were staff on hand at the laboratory who had located the foreshock and had informed the key client of that event. The key client was informed of the mainshock within minutes of it occurring.

The report generated by the Preparation, Alarm and Response system for the SRC nominated the most significant communication tasks to undertake and the general outcomes section broadly agreed with the isoseismal map depicted above.

Within hours of the mainshock the SRC began installing an aftershock network within the epicentral area. This network was augmented the next day with additional seismic recorders from the SRC and AGSO. The aftershock network comprised over 10 instruments at one stage.

1997 August 10, Collier Bay, MW 6.3

An earthquake of magnitude 6.3 occurred in Collier Bay in the Kimberley region of Western Australia on Sunday, August 10 at 05:20 pm WST. The epicentre was located 150 kilometres northeast of Derby, and 75 kilometres offshore from Koolan Island (124.3° east, 16.1° south).

Reports of it being felt were received from Broome to Kununurra. Some damage to concrete stumps of a single storey building occurred at Cockatoo Island, at a distance of about 75 kilometres. Modified Mercalli Intensity of 5 (strongly felt but no damage) was reported at Cape Leveque, about 150 kilometres from the epicentre.

The SRC SeisMonitor system is optimised to record earthquakes in southeastern Australia. However, the system does trigger on larger teleseisms, and for this earthquake sent the following pager message:

```
01: 1997-08-10 0926
CRN 19.2,00332,03.7
JBR 34.0,00085,08.4
WER 38.5,00068,06.7
AVO 41.0,00095,03.7
CDN ----,00062,06.6
TOM ----,00096,06.6
Group 4
19:32 10/8/97
```

The message gives in order the date and time of the trigger (in UTC) followed by information about the event as recorded at different sites in the format: Seismograph site code, number of seconds after the minute that the trigger occurred, peak counts for each channel and the maximum short term average over long term average ratio. Because the network of recorders used by the system is in southeastern Australia this event looked much like a teleseism and this event would usually have elicited no response from the SRC system. The SRC SeisMonitor system is optimised for southeast Australian earthquakes, and records a maximum duration of two minutes, so the S wave arrivals were not recorded for this event. A preliminary message was sent out by a staff member who happened to be at the laboratory.

```
02: Very large SHALLOW event,
probably Sunda Is or Banda Sea, GG
19:43 10/8/97
```

A revised message was sent after a preliminary location was determined. This location needed additional data from the Australian National Seismograph Network operated by AGSO, obtained using the Internet.

```
04: I make it MW 6 plus, about 200
km north of Derby, WA. It has been
felt Broome to Kununurra.
20:32 10/8/97
```

An aftershock network comprising four AGSO instruments was installed one week after the mainshock by AGSO and SRC personnel.

Because this event occurred so far outside the SRC seismograph network the Preparation Alarm and Response system identified no tasks.

1997 August 23, Mole Creek, ML 4.5

An earthquake of magnitude 4.5 occurred at 03:30 am on the morning of Saturday, August 24 with its epicentre near Mole Creek, 60 kilometres south of Devonport in Tasmania. It was recorded on seismographs operated by the RMIT Seismology Research Centre throughout Victoria and New South Wales.

This earthquake triggered the SRC SeisMonitor system which sent the following pager message:

```
02: 1997-08-23 1731
CDN 36.1,00244,05.7
TOM 36.5,00208,06.4
ROY 40.5,00542,06.4
GVL 41.9,00093,05.3
CRN 53.3,00244,06.1
DTM 55.8,00405,04.8
03:32 24/08/97
```

The duty seismologist determined that this was a local event requiring a response, dialled in to the laboratory and downloaded the waveform recorded by the SeisMonitor program before locating the event and sending the following pager message.

```
03:M? 4.5-5.0 70 km SW Launceston,
Tasmania.
04:26 24/08/97
```

Location of this event was difficult because it was well outside the SRC seismograph network. The Preparation, Alarm and Response system once again identified no further action to be taken for existing clients, because the event was so far outside the network. No aftershock network was installed.

3. CONCLUSION

A preparation alarm and response system has been developed to provide useful information to users regarding the likely effects of the earthquake, behaviour of various assets and the appropriate actions to take following a significant earthquake.

The system has proved useful for large events within the seismograph network but is difficult to use and has limited accuracy for events well outside the network.

For a rapid and precise location of an earthquake, a network of recorders surrounding the epicentre is required. It would be possible to minimise this limitation by linking a number of SeisMonitor systems over the Internet. Each sub network could broadcast its triggers to the other systems giving them access to a wider network of seismograph data and leading to a large network of independent sub-networks of seismographs.

The Preparation, Alarm and Response system is dependent upon the quality of the data input from both the seismograph network side and the database side (see figure 1). For a useful calculation of the effects and tasks to be carried out, a complete database of assets and vulnerabilities is required. However, care must be taken to minimise the size of the reports generated, and to include only significant information.

At present the SeisMonitor system is not autonomous. It requires trained and experienced personnel who are aware of its limitations, and are capable of making informed decisions regarding the actions to be carried out following the occurrence of a large earthquake.

Reference

1. Peck, W., Gibson, G. and McPherson, G. (1996). “Earthquake Warning, Alarm and Response Systems” *Proc. AEES seminar 1996*. Adelaide.