THE NEW ADELAIDE EARTHQUAKE MONITORING NETWORK

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PROJECT APPLICATION

Until recent years, the focus of earthquake monitoring in South Australia has been on the Flinders Ranges, with most data coming from a number of old analogue recorders established by the University of Adelaide in the 1970s and 80s.

With the inception of the Natural Disaster Mitigation Program (NDMP), I was encouraged to apply for funding for new instruments. I wrote a proposal to improve monitoring around Adelaide, focussing on hazard elements, and circulated it, particularly to SA Water, who had previously expressed interest in improving hazard assessment of their infrastructure.

In February 2005 the application was submitted, and a few months later SA Water offered to contribute some capital funds immediately, but on the condition that PIRSA supply all running costs. My management accepted, the State Government supported the proposal, and the application was successful.

The Commonwealth has now put $38M toward funding through the NDMP. This has been matched by State Government funds, and in many cases also local government funds. In South Australia 71% of this has gone towards the flood hazard, 9% to all hazards work, 5% to bushfires, with earthquakes being 2.2%. The high percentage going towards flooding is also reflected in the other states, but I believe my earthquake application is the only one funded to date. It is likely that the NDMP will continue in some form or another, and I would strongly urge others to put up proposals. The application needs to come from the State Government. It is normally expected that there will be equal local, State and Commonwealth funding, but for wide region hazards such as earthquake, the local component is considered less important.

Spending for the project has been difficult. SA Water funding only came right at the end of the financial year. Seismometers from Guralp have a lead time of around 6 months, but fortunately I was able to accrue these larger orders. Approval delays meant that other project money was not available until 6 months into the project. The main delays and problems at most stations have related to communications, so that station completion has taken much longer than ever expected. Despite all this the network is now running, and installations are nearly completed.

SITE INSTALLATION

The equipment being used is the Echo digital recorder from ES&S with inbuilt accelerometer, and external Guralp seismometer. The accelerometers are Silicon Designs 1221 with a full scale of 2 g and sensitivity of 15 micro g. The seismometers are mainly 6T-1 (1 sec, 3 axis instruments), with two being the 6T (30 second model).

Two new station enclosure arrangements have been used. One is a small above ground metal cabinet to house the battery, regulator and recorder, with the seismometer installed in a separate enclosure. This proved cheap and easy to install, but suffers from high temperature, as well as extreme temperature variation. Temperatures up to 60 degrees have been recorded which is about the specification limit for the Echo. We are investigating various ways to reduce this. The high temperature variation has lead to moisture problems at one site. However, this arrangement was particularly successful for temporary installations in the metropolitan area. A large paving slab was set up so that the cabinet could be easily installed on it. Large welded pegs enabled us to fix the paver quickly to most ground surfaces.

The second station enclosure arrangement was a concrete pipe (CPO pit) set in the ground. A second smaller pipe was set deeper inside this for the seismometer enclosure. This arrangement was more difficult to organise, but not particularly expensive. It has good temperature charateristics, and with extra insulation would be good enough for a broadband seismometer. There is spare room for more than the basic equipment.

Communications have been the biggest problem of the project. Installing phone lines in rural areas in the privatised era has taken much time and effort. We installed two new phone lines. One of these is particularly bad, so bad in fact that the local farmer has managed to get unlimited free calls from Telstra, who are not prepared to improve it. On top of this, the Echo has a particular problem with poor quality phone lines. The end result is that this station has been the worst performer in the network. Another station was connected to a new wireless broadband network on Yorke Peninsula. This has worked brilliantly, and has had almost zero downtime in the last 6 months. It needed only three 80W solar panels. Two other stations are running on CDMA . These have been highly reliable, but have the drawback that it is not possible to talk back to the recorder, and running costs are high. One of these has recently changed to a satellite service. The other may also be converted to satellite, however this has been delayed, as the landowner died, and property issues have not yet been resolved. We have not yet tried NextG modems. One site was on an existing telephone line with problems. It required four complaints to Telstra, and four trips to the site, before the problem was resolved. We are hoping this site can be converted to wireless broadband when the new Optus-Elders network begins. We intend to connect the old ADE vault into the system with a direct digital radio link, but fine tuning of the radios has not yet been successful.

Apart from the poor phone line problem, the Echos have been quite reliable in maintaining continuous telemetry (1 minute files by FTP), but have not been as successful at delivering other data stored locally on CF cards. This problem is being addressed by ES&S.

Project funding was $210,000. This covered everything, except my own time, and some time put in by other government employees.

PROJECT AIMS

The aims listed in the application were:
Improve hazard estimation for Adelaide and the Mt Lofty Ranges by:

- Detecting active faults and areas
- Recording strong motion shaking
- Determining spectral attenuation

Improve response to earthquakes by:

- Providing information rapidly
- Enhanced network robustness and redundancy

Improve mitigation planning by:

- Recording amplification in the CBD and metropolitan area
- Providing support for monitoring of structures in the CBD

We appear to be recording four times as many events near Adelaide with the new network. We have not yet recorded any strong motion, and it will be necessary to institute a testing regime to ensure that this part of the operation works when required. The network has been designed mostly with good coverage in mind, however the station spacing to the south and east is slightly less; the uneven spacing intended to assist in researching the attenuation properties. An extra station or two would have improved this aspect.

The information certainly comes in rapidly. Files from each station come in each minute. When a large event happens, triggers cause an automatic location and magnitude, which is sent by email. Emails usually come within 4 minutes of the first arriving waves. The accuracy of automatic location and magnitude is much better for larger events within the network. Location of deep overseas events is quite good. However there are many automatic estimates that are totally wrong. There is no doubt that extra on-line stations will improve this. We have not yet begun sending automatic results by SMS. For the central site we have battery backup, with computer and battery backup mounted under a robust desk, above floor level so that flooding, or earthquake damage is unlikely to stop the computer. The weakest point to date is the wireless router. We plan to have 3 stations connected by radio links, so that in case of total loss of the internet, some idea of direction to the epicentre is still possible. We are also considering sending data from selected sites to other networks.

We have recorded a few local events and a number of large teleseisms on the metropolitan equipment, but no analysis has been attempted yet.

The basic unfiltered display with all stations lined up makes detection of small events easy. Most stations are quiet at night, and noisy during the day as a result of wind, but even during the day it is possible to line an event up on a few quiet sites, download the data and filter, producing acceptable results. Overseas events can be located, often with surprising accuracy. Alison and I regularly check the network from home since it takes little effort to check it morning, noon and night. Future filtered displays will be even better.

THE STATE OF OBSERVATORY SEISMOLOGY IN AUSTRALIA

I was invited to speak at this conference because this network has been one of the few seismological improvements of recent years. This begs the question, what is the state of observatory seismology in Australia? From a number of measures it can be considered to be in rather poor shape. The number of located events has dropped significantly from 1990 to the present, although it appears this may finally be improving. The number of isoseismal maps produced per year has dropped dramatically in Australia, while public interest overseas is driving felt reports to new heights. The excellent record on focal mechanisms by Leonard et al (2002) shows that this area is not growing, while other countries are producing them regularly. Annual reports from observatories have ceased, and have only partially been replaced by web pages.

In short, Australian observatory seismology is not riding a wave at the moment. Is it even ready to get on the surfboard?

In the past, seismology has had to rely heavily on other disciplines for funding. There has been nuclear monitoring, which while it provided good funding for WWSSN stations, and later other digital stations, also only used 20 samples per second, and was not interested in dynamic range. Fortunately we have had good support from dam owners in eastern Australia to maintain and extend networks which has been of great benefit. Their interest has been closely aligned with ours. The finance poured into tsunami monitoring has been helping in recent times, but there is limited value for Australian seismology in a small number of super quality super broadband instruments. Current interest in mining induced seismicity has led to the installation of a considerable number of seismographs. Unfortunately the siting of these means they are only of limited value for other purposes. In the past I have had funding to monitor oil strandings thought to be caused by offshore earthquakes. I have been distracted by military interests, including recently in detecting scram jet remains. In recent times I have spent much effort on geothermal and pumping induced seismicity. Fortunately interest in geothermal energy has the potential to assist seismology.

We do not need top of the range instruments. We do not need world-leading research. We need lots of standard equipment, and standard processing. When this happens, some top quality instrumentation and research will follow.

The exposure of Australian seismology to the masses is low, and no organisation is riding a wave of never-ending web hits. This is a pity, because I have seen that there is much to promote in the area of general interest, hazard awareness and science. Many people have rain gauges for practical purposes, and real enthusiasts have weather stations for interest and pleasure. The BoM radar web page is a huge hit with bored office workers and bicycle riders. Many people have telescopes and spend time reading about the subject as well as perusing the heavens. Large sums of public money go into astronomy. I intend to make our on-line seismograph displays available to the public, but will take some time to make it happen properly. Information needs to be easy to access and up-to-date to catch the public interest. Scientists are bred at high school stage or earlier.

WHERE TO FROM HERE ?

What is our strategy for improvement ?

It is hard for me as an isolated, small observatory manager to speak as one who knows the broad landscape. I find myself not in regular communication with other observatories, and lacking the smooth data exchange and constantly improving software that I took for granted in the late 1980s. However, on reflection, that is possibly the case with most observatory focussed seismologists in the country today.

I recently attended a motivational talk. The speaker was proposing 100 new stores in the next year. His current store managers thought that was impossible. His response: Get rid of them - It can't happen while they are his front line.

On the subject of urban monitoring (JUMP) there has been a bit of activity in recent years, both through this society where high expectations have been tall poppied, and through GA. Mark Leonard is attempting to clarify instrumental requirements.

One of the landmarks in my seismological career was the conference in Newcastle 8 weeks after the 1989 earthquake. This society should commit itself to repeat the exercise when the next large event affects a populated area.

There has been a connection failure between observatory and university; between data collection and research. While there is communication, it has not produced substantial results. We do not have students, teachers and researchers knocking on our doors, and I don't think we are knocking on theirs. We need to promote our unsolved conundrums and holy grails as key research opportunities. In terms of prediction, we are where weather forecasters were in about 1890 – some patterns, but otherwise no clue. Without analysis and publication I fear our data are not of much value. I see my own failures too clearly in this regard.

There is considerable scope to work in conjunction with geothermal exploration companies. Some of their key concerns are the level of seismicity, likelihood of induced seismicity, and stress directions, all of which are also key questions in the hazard field, begging to be answered.

Now that capital costs have dropped significantly, running costs and office costs are the main problem. I consider that a cost effective way of substantially improving urban and regional monitoring would be through a long term Commonwealth subsidy scheme, with stations qualifying on the basis of equipment type, location and data delivery. This could be extended to state government, university and private organisations. Subsidy schemes at PIRSA are currently producing great results in mineral exploration, and the BMR Petroleum Search Subsidy Act in about 1960 produced gravity data that is still useful today.

Leonard, M, Ripper, ID and Yue, L , 2002. 'Australian earthquake fault plane solutions' Geoscience Australia, Record 2002/19