Seismic monitoring of CSG regions in NSW

Geoscience Australia (GA) and the New South Wales Trade and Investment (now Department of Planning, Industry and Environment) established a National Collaborative Framework agreement to undertake seismic monitoring of the NSW coal seam gas (CSG) areas as well as performing baseline monitoring in the region between 2015 and 2019. GA's role in this agreement is to establish and maintain seismic stations and identify events of local magnitude ML 2.0 and greater within the CSG fields. The agreement intended that three new seismic stations were to be located near Camden CSG area with two baseline stations in north-west Sydney.

Figure 1 Equipment (digitiser, switch, power distribution system, fuses, modem, State of Health) installed at MABG

Locations for the seismic stations were chosen to provide spatial coverage around the CSG field and supplement existing seismic monitoring in the region. They were in locations chosen to be as far as practical from anthropogenic noise while also maintaining good mobile communications coverage. A clear area was required for solar panels, GPS signal and reduced seismic noise. The seismic stations were assigned station codes based on their locations. They are: MABG [Mount Annan Botanic Gardens] (Figure 1), WTPK [Wilton Park] (Figure 2), CATI [Cattai], YARR [Yarramundi] and OKDL [Oakdale].

Figure 2 Cabinet and vault at WTPK

Location Uncertainty

In order to compare the location uncertainty of pre-Camden monitoring, a representative recent event was chosen within the region with a small magnitude. Small events generally have larger uncertainties in location due to the number of stations available to determine location. We have chosen an event (Figure 3) that occurred near Appin around the 30th of April 2019, as a magnitude MLa 2.2:

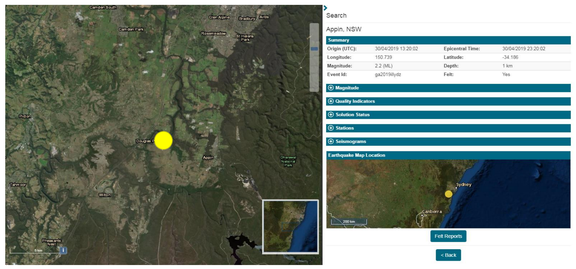

Figure 3 Appin earthquake, 30th April 2019 MLa 2.2

This event was processed in SeisComP3 using just the pre existing infrastructure (Figure 4) and a location was given near Appin with a location uncertainty of approximately 5km, and a large uncertainty ellipse:

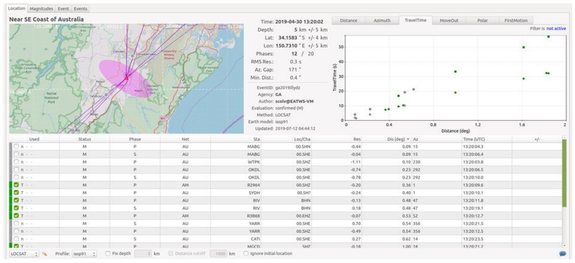

Figure 4 Appin 2019 event without new Camden network, showing uncertainty ellipse in SC3

When compared with the pre-existing infrastructure combined with the new Camden network (Figure 5), the uncertainty reduces to approx. 3km with a much smaller uncertainty ellipse:

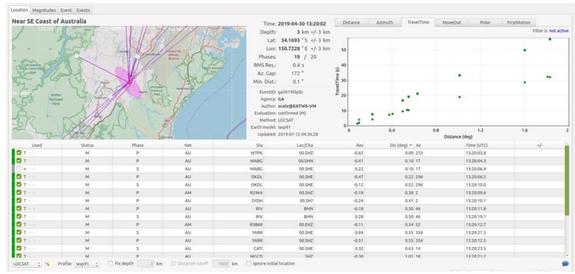

Figure 5 Appin 2019 event with new Camden network, showing uncertainty ellipse in SC3

Magnitude Reliability

When calculating the magnitudes of earthquakes it is important to have a high signal to noise ratio (SNR) so one can be confident in the magnitude being measured being more than the background noise at each station. The signal to noise ratio in the magnitude calculation using the pre-Camden infrastructure is shown in Figure 6 and observe that this is a very low quality solution with the highest SNR being 4 times the background noise, lowering our confidence in the solution:

When we reprocess the magnitude using all the new stations installed (Figure 7) in the Camden network this ratio is noticeably increased to an order of magnitude of 18-150 times the background noise. This gives us much greater confidence in the magnitude solution:

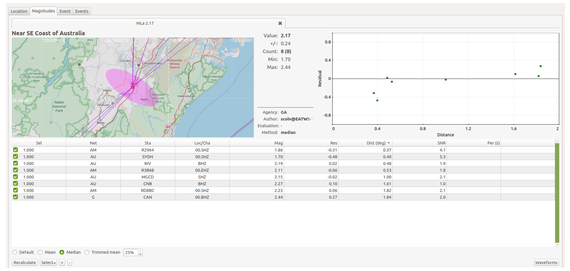

Figure 6 Magnitude calculation of Appin April 2019 event with pre existing infrastructure

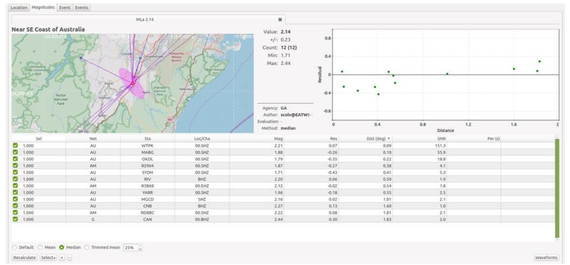

Figure 7 Magnitude calculation of Appin April 2019 event with existing infrastructure as well as the Camden network

Network Sensitivity

In order to show the increase in magnitude sensitivity of the network in the region of interest, we used NetMOD software from Sandia National Laboratories. This software takes into account all the metadata from stations including the noise models from each individual station. An improvement in detectability is shown to be 0.86, an enhancement of nearly a full relative magnitude than the sensitivity with previous infrastructure.

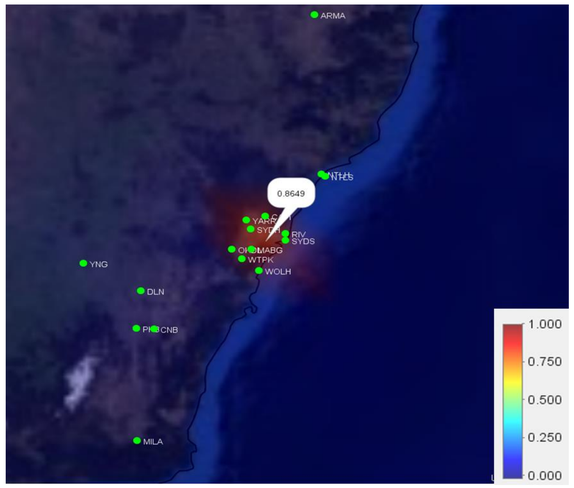

Figure 8 NetMOD output displaying the effect of the Camden network increase in detectable magnitudes.

References:

https://www.seiscomp3.org/doc/jakarta/current/index.html
https://www.osti.gov/biblio/1398882

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