

# AEES NEWSLETTER



March 2010

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## President's Report

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The last decade of the 20th century was dubbed the United Nations' International Decade for Natural Disaster Reduction (IDNDR). The International Association of Seismology and Physics of the Earth's Interior organised a contribution that became GSHAP, the Global Seismic Hazard Assessment Program, and a map of earthquake hazard for the whole world was published. Unfortunately the equivalent IAEE contribution WSSI or World Seismic Safety Initiative wasn't realised. The reason for the declaration of the 1990s as the IDNDR was that over the previous 100 years nearly 10,000 people were killed per year on average as a result of earthquakes, a quarter of them in a single earthquake near Tangshan China in 1976. In Australia there were 15 earthquake fatalities in the century.

Already by 2009 this century the death toll had exceeded 653,000. One might conclude that either the IDNDR was a complete failure, or governments chose to ignore the warning inherent in the GSHAP maps, the level of seismicity has not changed.

Take the case of Haiti on the back steps of the US. Destroyed twice previously by earthquakes in the last 400 years, the capital city of Port-au-Prince straddles a plate boundary and now with a population of more than 3 million people has again been flattened with devastating consequences. On 12th January 2010 a major magnitude 7 earthquake caused a great disaster; the collapse of many buildings including homes, schools and hospitals, the main Cathedral, presidential

buildings and UN headquarters leaving a reported 200 000 people dead and more than a million people homeless. On 27<sup>th</sup> February Chile suffered a great earthquake causing a moderate disaster, perhaps a thousand killed in collapsed buildings and subsequent tsunami. How could this be? what is happening?

Have there been more earthquakes? No! Worldwide records collected since 1900 show that every year there are about 10 to 12 shallow magnitude 7 or greater earthquakes on average and this hasn't changed since 1990.

Did GSHAP change anything? the publication of a global map of earthquake hazard? It certainly didn't drive any change in region 10 of the GSHAP map which covered New Zealand, Australia, Indonesia and all the countries of the SW Pacific in between. Papua New Guinea hasn't had a building code upgrade since 1982, the Solomon Islands doesn't have a building code, Indonesia is in the process of upgrading its code, Samoa uses an old code based on a superseded NZ loading code. Both Australia and New Zealand have updated their codes though not influenced by GSHAP. It is doubtful there was any follow-up after the GSHAP map was published, few engineers would have known about it let alone politicians. Haiti had no earthquake code.

One of the contributing factors to the increasing casualty figures worldwide is population growth. Haiti's population has doubled since about 1970 and it now has the highest population density of any country in the western hemisphere. The current population of Port-au-Prince has been estimated at up to 4 million, quadruple the number in the mid 1990s. Another contributor coupled with the lack of an earthquake code is the poor quality of materials and construction.

A poll of senior members of AEES including the committee concluded that Haiti, half way round the World and at the backdoor of the US, was outside our area of influence and that we would not send a team to investigate the damage. We are discussing the possibility of sending a joint NZ/Aus team to Chile.

What else can/should we do? Let us make a contribution in our area of interest/influence. GSHAP region 10 is a good starting point. We need to assist neighbouring countries develop earthquake codes specific to their needs which should incorporate an earthquake hazard map. We have already raised the possibility of jointly sponsoring earthquake code

development in the SW Pacific with the NZSEE and made a start with PNG (thanks to Lawrence Anton, see the last two AEES conference proceedings). It could be as simple as adopting the current Australian or New Zealand codes and assessing the hazard factor Z. We need to encourage development and application of software like EQLIPSE to identify cities most at risk and work at a political level to have codes adopted and enforced there, even encouraging retrospective application for special structures like schools and hospitals.

The NZSEE has decided to hold the next Pacific Conference on Earthquake Engineering (PCEE) in New Zealand in 2011 which would be an excellent opportunity to roll out a program in our region. We need to start work now to identify appropriate professional engineering organisations in each SW Pacific country and raise support for getting their delegates to the PCEE.

AEES must also establish a register of members prepared to participate in post-disaster investigations, seismologists and engineers, and we are most grateful to the AEES members who, at short notice, went to Sumatra as part of the AusAID team facilitated by Geoscience Australia last year, and reported on at AEES2009 in Newcastle. If you are interested please contact me or the Secretariat.

Kevin McCue  
President

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### **Request for Proposals: GEM Risk Global Components**

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GEM (Global Earthquake Model) aims to achieve its goals by developing state-of-the-art open source software and global databases necessary for reliably mapping earthquake risk. To this end, GEM has issued five requests for proposals for Global Components of its Risk Module. GEM's Risk Module will calculate damage and direct losses resulting from this damage, such as fatalities, injuries and cost of repair.

The five RfPs cover the following topics: GEM Ontology & Taxonomy, Inventory Data Capture Tools, Global Exposure Database, Global Earthquake Consequences Database and Global Vulnerability Estimations methods; the target budgets for these calls range from 300,000 - 900,000 €. The deadline for submission is 18th March 2010, 0:00 CET. More information can be found by visiting the GEM website [link below to [www.globalquakemodel.org/node/373](http://www.globalquakemodel.org/node/373) <<http://www.globalquakemodel.org/node/373>> ].

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### **Earthquakes threaten geothermal power**

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New Scientist Environment

Geothermal energy is in the dock in Germany, but some scientists are pleading for leniency.

A government panel is investigating claims by the geological survey for the state of Rhineland-Palatinate that a geothermal plant triggered a magnitude-2.7 earthquake on 15 August in the town of Landau in the state. If the panel finds against the company that built the plant, Geo X of Landau, it could be shut down.

Geothermal plants work by pumping water into hot rocks several kilometres down, forcing small cracks in the rock to expand. Steam escapes through the cracks to the surface, where it drives a turbine, producing clean energy. But critics say the process increases the risk of earthquakes.

"Any process that injects pressurised water at depth into rocks will cause them to fracture and possibly trigger earthquakes," says Brian Baptie, an earthquake specialist at the British Geological Society.

Whose fault is it?

Engineers rather than technology must take some of the blame, says Roy Baria, a geophysicist on the panel reviewing the Landau quake, who also works for geothermal energy company EGS Energy, based in Penzance, UK. Past quakes triggered by plants in Basel, Switzerland, were avoidable, he says. "The engineers failed to adhere to best-practice guidelines."

Even the worst geothermal earthquakes have failed to topple a building or kill a human, says Ernest Majer, a seismologist at the Lawrence Berkeley National Laboratory in California, pointing out that geothermal power isn't the only industry that triggers earthquakes.

"Any industry which injects high-pressure fluid into rock, and that includes the oil, nuclear and carbon sequestration projects, has the potential to cause tremors," he says.

(Ed: there is a lesson here for Australia).

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## Letters

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Subject: Estimates for Haiti Earthquake.

Dear Kevin,

It was great to meet you at the AEES conference, and look forward to seeing you again next year.

I noticed a quote on a website regarding the Haiti Earthquake from you and I thought that you might be interested in my estimate of socio-economic losses.

I use a hybrid methodology to come up with my estimates. With more information these will be refined. It is a rapid loss scenario-based method (similar to WAPMERR and PAGER-CAT, but different again). I am hoping to automate this by the end of the year.

Kind Regards,

James Daniell.

EQLIPSE HAITI EARTHQUAKE SOCIO-ECONOMIC LOSS ESTIMATES

(<http://www.world eqlipse.com/phpbb/viewtopic.php?f=3&t=17>)

With over 220,000 people exposed to intensity IX and above, and over 3,000,000 people exposed to intensity VII and above.

There has only been a greater earthquake in Haiti in 1842 with 5000 deaths caused by a M8.1 earthquake.

An earthquake of Mw5.7 occurred 25.01.1953 with 2 deaths recorded, and an earthquake of Mw5.4 occurred in 1994 with 4 deaths recorded.

However, this Mw7.0 earthquake is catastrophic, even taking the lower estimate of the deaths via EQLIPSE.

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Subject: School Seismology

Dear Kevin,

Can you check out [http://www.bgs.ac.uk/education/school\\_seismology/seismometer.html](http://www.bgs.ac.uk/education/school_seismology/seismometer.html) please?

There are two good quality seismometers designed for school use here. The SEPUK records from 5 Hz to over 20 seconds with a 16 bit ADC. The sales according to MUTR have now exceeded 400!

This seems to be a very successful project by the BGS.

Is there any chance of getting a secondary school in your area interested?

Regards

Chris Chapman MA (Physics)

[ChrisAtUpw@aol.com](mailto:ChrisAtUpw@aol.com)

## Media release

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### Indonesia Recovery and Reconstruction Assistance

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Australian urban search and rescue workers examine a building in Padang, West Sumatra, damaged by a magnitude 7.6 earthquake on 30 September 2009.

Australia responded quickly to the earthquake with a \$2.8 million response package. This initial response included a 36 person search and rescue team, relief supplies, including cooking hygiene and medical kits,

and military health and engineering assessment teams to the disaster area.

Our initial response focused on search and rescue. At the height of this phase Australia had 582 personnel committed to Indonesia. This includes 570 ADF personnel, of which 323 are onboard HMAS Kanimbla, 13 Embassy personnel on the ground in Padang and a 36-member Queensland Fire and Rescue Service team.

Our response has now moved towards the relief and reconstruction phase. Initial needs assessments identified water supply, medical care and shelter as the key priorities and Australia is responding to these needs.

Australian civilian and military personnel in Padang and the surrounding region are now involved in a Joint Task Force assessing and carrying out recovery operations. The task force includes ADF medical and health specialists providing medical assistance through an Australian field hospital located 75km north of Padang. ADF engineers are also establishing water purification plants and assessing infrastructure.

Australia maintains relief supplies in Indonesia in preparation for these types of emergencies. Some of these stores have been released to the Red Cross in Indonesia including 1290 family kits each designed for a family of four and 50 family tents. These kits contain much-needed basic goods such as clothes, soap and tarpaulins.

Australia has also provided support to Indonesian non-governmental organisation Muhammadiyah and Nahdlatul Ulama to provide medical teams, temporary schools, school books and trauma counselling.

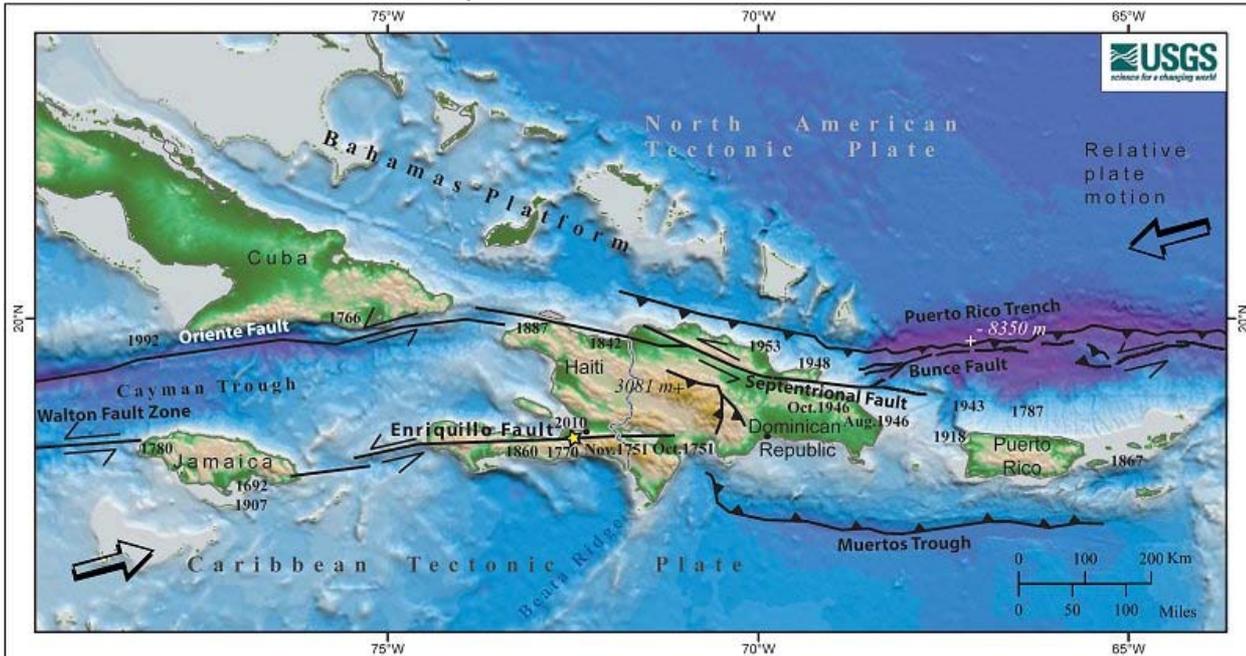
Australian officials are working closely with colleagues from the Government of Indonesia to ensure that our assistance helps to relieve the suffering of those affected by this disaster.



Photo AusAID Indonesia

## The Haiti Earthquake

16:53 local time (21:53 UTC), 12 January 2010



This is the second deadly earthquake this century with casualties in the hundreds of thousands. Unlike the Sumatran earthquake of December 2004, this was not of great magnitude, nor did it cause secondary effects such as a tsunami or widespread landslides to contribute to the destruction. The latest estimates of casualties in the magnitude 7.0 earthquake: deaths exceed 200,000 with more than one million homeless! All of these deaths are due to building collapse, no landslides, no tsunami, no fires, not even a fault scarp.

The earthquake occurred in the collision zone between the Caribbean and North American plates (see figure above from the USGS, the yellow dot is the epicentre or initial point of fault rupture). It was a major, shallow earthquake close to a capital city, Port au Prince, with more than 3 million residents. A capital city whose buildings were not designed to resist an earthquake, nor built accordingly.

The earthquake ruptured a 50-60-km long section of the more than 500-km-long Enriquillo-Plantain Garden Fault, which runs east-west through Haiti, between the Dominican Republic in the east and Jamaica to the west.

The fault system is a "strike-slip" fault, the Caribbean Plate south of the fault sliding east and the smaller plate fragment, the Gonave Plate north of the fault, was sliding west. The situation is similar to California's San Andreas Fault, another better known transform fault.

This is not a fast moving fault, perhaps 7mm/yr, so earthquakes are relatively infrequent on it but are well known to occur in the fault system (see below).



Apartment above in Haiti. Pancake collapse opposite



The Haiti earthquake did not trigger a tsunami because its epicentre was on land and its mechanism strike-slip, mostly horizontal movement. No pictures of the fault scarp have so far been published.

The earthquake caused major damage to Port-au-Prince, Jacmel and other settlements in the region. Many notable landmark buildings were significantly damaged or destroyed, including the Presidential Palace, the National Assembly building, the Port-au-Prince Cathedral (right), and the main jail. The headquarters of the United Nations Stabilization Mission in Haiti (MINUSTAH), located in the capital, collapsed, killing many, including the Mission's Chief, Hédi Annabi. Also killed were opposition leader Micha Gaillard and Archbishop of Port-au-Prince Monsignor Joseph Serge Miot.



*Collapsed school (left) and damaged cathedral (above)*

There does not appear to be a record of the ground motion but no doubt the ground shaking was strong and the strong motion lasted perhaps 30 seconds (using Ambraseys' formula) but even under those extreme conditions, buildings should be able to remain standing as many indeed did even though they were not designed or built to an earthquake loading code. With such planning the death toll could have been a fraction of what occurred. Now countries from around the world are contributing to the huge relief effort but if they had contributed earlier with directed aid and education, surely this disaster could have been averted or at least mitigated. Will they stay the distance and ensure the replacement buildings are robust, are designed and built to withstand the next earthquake whether it is next year or another 200 years in the future, and Haitians are educated to build a more resilient, self reliant society?

The lesson of all this is that we should now be looking more closely at our own region. We should be teaching young engineers and scientists from the SW Pacific, we should be helping them develop loading codes for their individual situation, developing hazard maps and codes and most importantly, keeping them up to date. Lastly we should be a bit introspective and see whether what we are doing here in Australia is sustainable, whether our school children and hospital patients are safe, educating our fellow Australians that earthquakes do happen here and that they themselves can act to make their home and office more secure.

#### **History of past earthquakes in or near Haiti:**

In 1946, a magnitude 8.1 earthquake, struck the northeastern corner of Hispaniola causing many casualties. The likely sequence of earthquakes on the Enriquillio fault to 1860 are as follows (from USGS).

- October 18, 1751: a major earthquake caused heavy destruction in the gulf of Azua (the eastern end of the Enriquillio Fault) which also generated a tsunami. It is unclear if the rupture occurred on the Muertos thrust belt or on the eastern end of Enriquillio Fault.
- Nov. 21, 1751: a major earthquake destroyed Port au Prince but was centred to the east of the city along the Cul de-Sac plain.
- June 3, 1770: a major earthquake destroyed Port au Prince again and appeared to be centred west of the city. As a result of the 1751 and 1770 earthquakes and minor ones in between, the authorities required building with wood and forbade building with masonry.
- April 8, 1860: there was a major earthquake farther west accompanied by a tsunami.

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## The Chile earthquake

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03:34 am local time (06:34 UTC), 27 February 2010

Saturday, February 27, 2010 at 03:34:14 am local time, a great earthquake Mw 8.8 struck the coast of Chile, causing extensive damage in Chilean cities. Many buildings including more than 500 000 homes were destroyed. The earthquake triggered a Pacific-wide tsunami, locally measuring 2.34m in the port city of Concepción. The tsunami caused serious damage to port facilities and drove boats ashore.

The epicentre was 115km north-northeast of Chile's second largest city, Concepción, and 325km southwest of the capital Santiago but aftershocks in the first few days outlined a 700km long bilateral rupture zone extending as far north as Santiago, explaining the high intensity there.



*Aftershock extent after 2 days extending north and south of the epicentre.*

Shaking is reported to have lasted three minutes, the Mercalli intensity rated VII (very strong) in Santiago, and VIII (destructive) in other cities such as Arauco, Concepción, Chiguayante, and San Antonio.

Chilean president Michelle Bachelet declared a state of catastrophe and confirmed the deaths of at least 723 people. The Chilean minister of housing Patricia Poblete estimated that the earthquake had damaged 1.5 million homes and had affected 2 million people.

In the disaster zone, extending from Valparaíso to Araucanía, eight hospitals are unusable and 10 have major damage although 76 hospitals are operating without major difficulties.

Some seaports suffered structural damage. The airport in Concepción was closed to commercial flights, but the main airport in Santiago reopened quickly.



*An apartment building in Concepción*

The Chilean coast is no stranger to mega-thrust earthquakes and in 1960 was the site of the greatest earthquake ever measured, the magnitude rated at 9.5. The epicentre of the 1960 earthquake was near the southern edge of the aftershock zone of the 2010 earthquake and in 1960 the fault ruptured from the epicentre to the south.

Tsunami warnings were issued in 53 countries including the east coast of Australia and a small tsunami was recorded on tide gauges, at one site in New Zealand the tsunami was more than 1m high. Most of the slip on the 700 km long fault plane was in the depth range 20 to 40km deep which explains why the tsunami was not as large as expected.

Following a formal request from the Chilean ambassador, the Australian government made an initial contribution of \$1 million in emergency supplies including 50 portable generators, 150 family tents and 1060 field beds for affected communities. Australia will also make an initial contribution of \$4 million in reconstruction assistance following detailed needs assessments by Chilean authorities. Australia has committed to providing emergency and reconstruction assistance. Australia is also considering sending a team of structural engineers to support the Chilean Government to carry out damage assessments on public buildings and infrastructure affected by the earthquake (AusAID website on 12 March 2010).

AEES has had preliminary discussions with NZSEE regarding the possibility of participating in a joint New Zealand/Australia mission to Chile to learn from the earthquake. Buildings there have been designed and built according to modern codes yet new buildings like the one above suffered severe damage. Importantly there is a network of strong motion recorders throughout Chile and initial data distributed unofficially indicate that the shaking was quite a lot stronger than the code spectrum. We hope to be able to release the data in the next newsletter.

These two earthquakes, in Haiti and Chile, exemplify a common paradox, in one case a major, shallow, close earthquake duration 30s causing a huge disaster (Haiti), in the other (Chile) a great, shallow, close earthquake duration 350s causing a modest disaster. A lot is expected to be learned from Chile after the analysed strong motion records are compared with the damage to properly engineered structures, but it is doubtful there will be any new engineering lessons to come from Haiti. This is perhaps the first lesson for Australia; it is very beneficial after the earthquake to have an accurate record of the ground shaking. How valuable it would have been in Newcastle after the 1989 earthquake to have had recordings of the ground motion in Hamilton and other suburbs of Newcastle. Having appropriate equipment installed would have been a small price to pay.

Bill Jordan take a bow. The conference was over all too early, at least for the participants if not the organisers. It was another significant contribution to our knowledge of earthquakes and their effects in Australia and a convivial gathering of most of the active participants in earthquake engineering in Australia and prominent regional experts. I have never had so many emails from members saying how much they enjoyed the conference. On the 20th anniversary of the Newcastle earthquake let's hope our efforts contribute to Newcastle 1989 remaining the worst Australian earthquake disaster ever.

The keynote talks were particularly good, Professor Melcher's analysis of the failure of the Workers Club so pertinent to the theme and naturally of great interest to Novocastrians and it garnered front page of the Newcastle Herald on 12 December 2009. It was a significant victory of our right-to-know over threats of litigation still hanging around 20 years later. Rod Caldwell's movie was poignant, bringing the earthquake's impact on the electrical network back in time, an amazing restoration effort. The talks by Drs Paul Somerville, John Adams (Canada) and Mark Stirling (New Zealand) serendipitously coincided with Geoscience Australia's return to earthquake hazard assessment for the next generation Australian Loading Code.

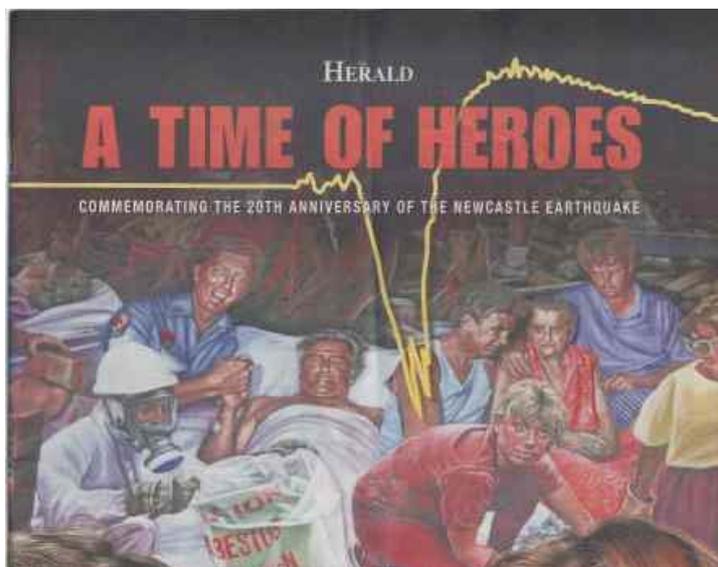
Gary Gibson's talk was cut short but the written paper should be read closely by everyone doing or using a probabilistic seismic hazard assessment. Student papers maintained the high standard of previous years, the best student presentation judged to be that of James Daniell on loss modelling. Session chairs were well briefed on their roles and the 3-minute poster presentations worked very well as a consequence. The sessions were memorable for the lack of audio-visual problems.

AEES's very attractive AS1170.4 Code Commentary was launched at the conference, a tribute to Professor John Wilson and his team. We just hope it doesn't signal the complete withdrawal of Standards Australia from the field.

The experiment of the public forum on Saturday afternoon wasn't a great success in attracting participants on a hot Saturday afternoon but Christ Church Cathedral was a magnificent setting for the talk by Bill Jordan and Barney Coffin about the post-earthquake strengthening of this heritage listed building (soon available on the AEES website) and a warm service afterwards to commemorate those who died in the earthquake-induced collapse of the Workers Club and shopfront awnings on Beaumont Street Hamilton.

The social dinners on Friday night on the most attractive Newcastle waterfront and Saturday night at the formal Newcastle Club were memorable, a very talented musical trio on the Saturday night and the bard from Gin Gin Queensland, Mike Turnbull in impeccable form. Everyone participated in the options game and it was interesting to see who was left standing at the end.

Congratulations to the organisers, Bill Jordan and his Newcastle team with Sharon Anderson running the secretariat from Melbourne. Thanks also to all those other helpers, the paper reviewers, Lord Mayors past and present, John McNaughton and John Tate, the forum panelists and University Chancellor Professor Trevor Waring. The organisers addressed the media involvement properly and did attract a lot of publicity in newspapers and on radio though this didn't translate into record numbers attending the conference which was a little disappointing.



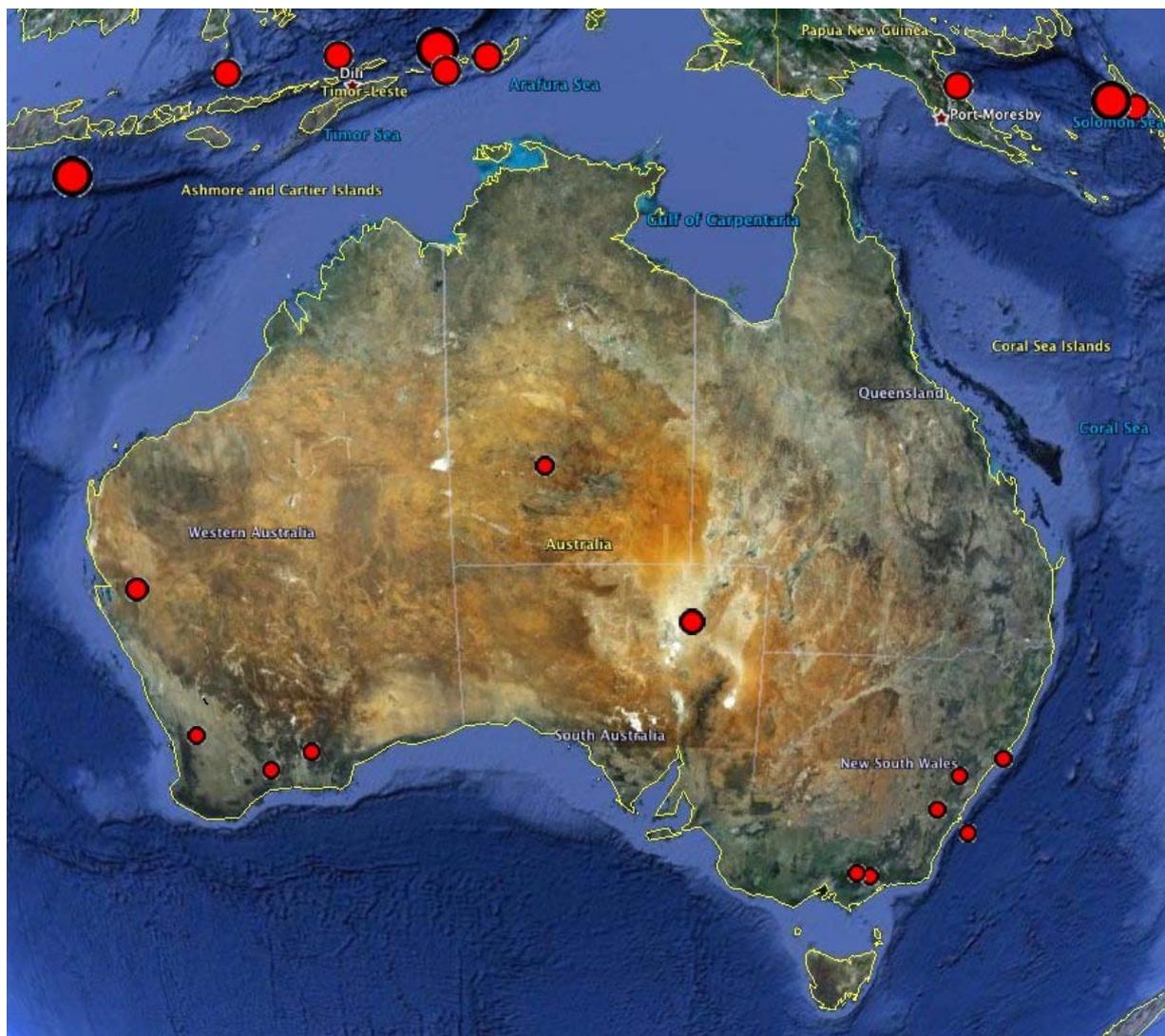
Professor Hong Hao has invited us all to Perth next November for AEES2010 at the University of Western Australia so it would be prudent for you to start thinking now about your presentation, a call for papers will be issued shortly.

## Australian earthquakes: Jan - Mar 2010

In contrast to the high level of world seismicity so far in 2010, there have been few earthquakes in Australia, the largest a magnitude 3.8 earthquake near Mt Rebecca WA (see table below). Several of the earthquakes were felt including the last event listed that was felt by many residents of Newcastle NSW.

Date	Time(UTC)	Lat °S	Long °E	ML	Depth km	COMMENTS
08-Jan-2010	14:24:34	37.49	147.01	2.8	17	SW of Dargo Vic
14-Jan-2010	21:35:36	33.15	120.28	2.5	0	N of Ravensthorpe WA
15-Jan-2010	13:47:12	31.70	117.04	2.5	0	Meckering WA
26-Jan-2010	18:25:31	26.08	115.51	3.8	4	Mt Rebecca WA
03-Feb-2010	05:02:03	27.98	138.14	3.6	1	NE Lake Eyre SA
06-Feb-2010	19:31:18	33.36	150.29	2.6	11	NE Lithgow NSW
14-Feb-2010	10:14:36	32.51	122.31	2.9	0	SE Norseman WA
20-Feb-2010	18:50:01	34.71	149.58	3.0	6	NW of Goulburn NSW
28-Feb-2010	05:08:43	37.36	146.32	2.7	12	E Jamieson Vic
10-Mar-2010	00:45:17	35.63	151.40	3.0	0	Off Ulladulla NSW
11-Mar-2010	12:57:53	22.63	132.57	2.8	18	NW Alice Springs NT
11-Mar-2010	16:25:08	32.62	152.25	3.3	0	Nelson Bay area NSW

*Earthquakes in the Australian region Jan - 13 Mar 2010 located by GA, ES&S, SADME and ASC*



*Figure obtained using GoogleEarth and GA database online.*

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## Conferences

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### 2010, 26-28 March, NZSEE Annual Technical Conference and AGM, Wellington.

The 2010 conference theme is "Earthquake Prone Buildings: how ready are we?".

The New Zealand Society for Earthquake Engineering Conference is an annual forum where current research and practice related to earthquake engineering is presented in papers and posters.

In 2010 the conference will be held at the iconic Museum of New Zealand Te Papa Tongarewa. Professor Michele Calvi will deliver the keynote address on the 2009 L'Aquila Earthquake in Italy. A panel forum will stimulate discussion on New Zealand's readiness for the 'big one' and a special session will honour the lifetime achievements of Professor Tom Paulay. Field trips on the Saturday afternoon will showcase Wellington's assets, faults, hazards, and their mitigation.

**2010, 17-24 May** AGU Chapman Conference on Giant Earthquakes and their tsunamis Valparaíso, Viña del Mar, Valdivia, Chile

**2010, 22-25 June** Western Pacific Geophysics Meeting Taipei, Taiwan.

**2010, 8-12 August** 5th Civil Engineering Conference in the Asian Region and Australasian Structural Engineering Conference 2010. Sydney Convention and Exhibition Centre.

[www.cecar5.com](http://www.cecar5.com)

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### The 2010 AEES Committee

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## Worst earthquakes of the last decade

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Largest Earthquakes (USGS)					Deadliest Earthquakes (USGS)				
Year	Date	M	Deaths	Region	Year	Date	M	Deaths	Region
2010	02/27	8.8	800	Chile	2010	01/12	7.0	200,000	Haiti
2009	09/29	8.1	192	Samoa Islands region	2009	09/30	7.5	1117	South Sumatra, Indonesia
2008	05/12	7.9	87,587	Eastern Sichuan, China	2008	05/12	7.9	87,587	Eastern Sichuan, China
2007	09/12	8.5	25	South Sumatra Indonesia	2007	08/15	8.0	514	Central Peru
2006	11/15	8.3	0	Kuril Islands	2006	05/26	6.3	5,749	Java, Indonesia
2005	03/28	8.6	1313	North Sumatra Indonesia	2005	10/08	7.6	80,361	Pakistan
2004	12/26	9.1	227,898	North Sumatra	2004	12/26	9.1	227,898	North Sumatra
2003	09/25	8.3	0	Hokkaido, Japan	2003	12/26	6.6	31,000	Southeast Iran
2002	11/03	7.9	0	Central Alaska	2002	03/25	6.1	1,000	Hindu Kush, Afghanistan
2001	06/23	8.4	138	Near Coast of Peru	2001	01/26	7.7	20,023	India
2000	11/16	8.0	2	New Ireland Region PNG	2000	06/04	7.9	103	South Sumatra, Indonesia