South Africa Spotlight on Earthquake

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Introduction

Aon Benfield and the Aon Benfield Natural Hazard Centre Africa at the University of Pretoria have collaborated to look into one of the largest risks facing the people, government and insurance community in South Africa: earthquake. Regarded as the natural hazard most likely to trigger the country’s largest financial loss, this report combines science and insurance industry expertise to help prepare for a seismic event.

The new research into potential earthquake magnitudes and probabilities, represented in catastrophe models, will enable insurers to obtain a more accurate estimate of their exposure and in turn purchase appropriate reinsurance cover.

The report also helps to set the record straight around the recent hype on predictions of a Haiti sized scenario for Cape Town and Durban. While we address the question of large earthquake magnitudes in South Africa, this is put in the context of return periods associated with these events.

With South Africa in the spotlight for the 2010 FIFA World Cup, we use the Cape Town Stadium and Durban’s Moses Mabhida stadia as case studies to illustrate the low probability of high magnitude earthquakes.

Even though Johannesburg has the highest total exposure, we focus on Cape Town and Durban due to their experience of the largest seismic events recorded in South African history and where we would most likely expect the largest damage.

The Science

Seismicity in South Africa

The south-western Cape has one of the highest levels of seismicity in South Africa, which is characterised by its dual source of seismicity comprising mine related events and tectonic origin earthquakes.

According to new research from Professor Kijko, director of the Aon Benfield Natural Hazard Centre Africa, the Western Cape Province, with Cape Town as the capital city, can expect a maximum earthquake close to magnitude 7.0. By comparison, the largest mine related event in the Johannesburg gold mine area is estimated at magnitude 5.6.

Historically, the most severe earthquake of magnitude 6.3 occurred on 29 September 1969 in Ceres, 100 km northeast of Cape Town. The event resulted in 12 lost lives and numerous damaged buildings in the town of Tulbagh. On 4 September 1809, a seismic event estimated at magnitude 6.3, occurred at the Milnerton Fault, a mere 10km from Cape Town CBD and the location of the Cape Town Stadium.

The largest mine related event in the history of South Africa occurred on 5 March 2005 in the Klerksdorp (Stilfontein) gold mining district, 200km west of Johannesburg, which reached a magnitude of 5.3. Below ground, substantial damage was observed within the mines, while above ground, the structural damage to property was relatively low.
Mining related events add a low magnitude, high frequency facet to earthquake risk in Johannesburg. It is also believed that accumulation of water within old mine shafts of several kilometres deep can trigger small, and occasionally moderate sized, seismic events.

The tectonic origin and mining related events are considered to be largely uncorrelated. As mining activity around Johannesburg diminishes with the depletion of gold reserves, so has the risk of mining induced seismic events originating below the city.

### Seismic risk in Cape Town

Cape Town was exposed to an earthquake at the Milnerton Fault in 1809, so the Aon Benfield Natural Hazard Centre investigated the potential probable maximum loss (PML) that could be caused by a similar earthquake in the future.

Seismic events were selected from a catalogue of earthquakes in South Africa that occurred between 1620 and 2006 within a 300km radius from Milnerton. The results of the hazard analysis, in terms of the mean return periods, were calculated for range of expected magnitudes from 3.0 to 6.87 – as referenced in Figure 2.

The figure shows for example that an earthquake of magnitude 6.0 and larger can be expected to occur once in 300 years in the selected area surrounding Cape Town. It must be emphasised that the predicted upper limit earthquake magnitude for the area is 6.87.

**Figure 2 Magnitudes and return periods for earthquakes in the Cape Town area (200km radius)**

Assuming the worst case scenario of a 6.87 magnitude earthquake at the Milnerton Fault, the predicted Mercalli Magnitude Intensity (MMI) in the Cape Town CBD and the Cape Town Stadium would be about IX or ‘ruinous’.

The chart below shows expected damages from a MMI IX earthquake and their uncertainties for three types of buildings, which represent approximately 70% of all South African urban structures (Davis and Kijko, 2003). As the financial sector is robust and closely involved in financing insurable commercial and residential property, building standards for these are enforced and regulated by local authorities.

<table>
<thead>
<tr>
<th>Building type</th>
<th>Expected damage</th>
<th>Uncertainty</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unreinforced masonry with load bearing wall, low rise</td>
<td>45 %</td>
<td>30% - 61%</td>
</tr>
<tr>
<td>Reinforced concrete shear wall without moment resisting frame, medium rise</td>
<td>20 %</td>
<td>12% - 29%</td>
</tr>
<tr>
<td>Reinforced concrete shear wall without moment resisting frame, high rise</td>
<td>27%</td>
<td>16% - 37%</td>
</tr>
</tbody>
</table>
Seismic risk in Durban
Durban, the largest port city in South Africa, is located next to the warm Indian Ocean and is not regarded as being exposed to high seismic risk. A magnitude 6.3 event occurred at St Lucia Estuary, about 220 km north of Durban, on New Year’s Eve 1932 but – unlike Cape Town – there is not an active known fault close to the city.

The return periods for earthquakes of magnitude 5.0 and 6.0 were assessed considering all seismicity within a 300 km radius of Durban. From this research, it is estimated that an earthquake of magnitude 5.0 could cause structural damage only if its epicentre is less than 45km from Durban. The return period for such an event is about 735 years.

Using the Moses Mabhida Stadium as a case study, for a magnitude 6.0 event and larger to occur and have a damaging impact, the epicentre must be closer than 90km. The return period for such an event is about 5,000 years. It is clear that earthquakes are not a significant risk to insured structures in Durban, although the contribution to expected losses must be taken into account.

The (re)insurance
Catastrophe reinsurance
South Africa contributes 0.7% to the global reinsurance market with an estimated ZAR6.6 billion short term (non-life) reinsurance premium. An estimated ZAR23 billion (USD3 billion) of catastrophe reinsurance is purchased, which covers all natural perils including flood, windstorm and hail. Local insurers tend to purchase reinsurance programs to recover at least a 1 in 250 year event, on the advice of the Financial Services Board regulator.

Exposure in South Africa is divided into 16 CRESTA zones. CRESTA 5, 6 and 7, which include the financial heartland surrounding Johannesburg and Pretoria, contribute 40% of the total exposure, while Cape Town and Durban equal 25% combined.

Catastrophe purchase is usually determined by exposure aggregates in CRESTA 5, 6 and 7, which are characterised by high exposure and low magnitude seismic activity from gold mines 4km deep. Traditionally insurers purchased catastrophe reinsurance at 2.5% of CRESTA 5, 6 and 7 exposure; although this number has decreased to below 2% after the introduction of new catastrophe earthquake models for the region which present a more accurate picture of the risk.

Impact on the insurance market
Catastrophe reinsurance premium rates have reduced in recent years and business is in demand with international reinsurers as it provides good diversification from traditionally predominant US and European exposures. There has also been a lack of catastrophe events over the last decade resulting in further downward pressure on premium rates. This also means that South African insurers’ catastrophe retentions are low compared to other markets.

An earthquake would mainly affect the local South Africa insurance market in terms of claims and would create a perception of increased risk. This could lead to higher insurance rates locally but would not impact the global reinsurance market significantly.

Conclusion
South Africa’s large magnitude earthquakes have a low frequency.

The new academic research into seismic risk in South Africa enables Aon Benfield to improve its catastrophe models by updating provision for both mining related and tectonic origin seismic events. At the same time, the research can be used as a method of quantifying required catastrophe reinsurance cover and help insurers better manage their balance sheets.

Using scientific expertise from one of South Africa’s leading universities, this report helps both insurers and reinsurers operating in South Africa to appropriately price catastrophe risk for potentially the largest natural hazard in the region.

References

Contact
Pieter Visser
Aon Benfield, Johannesburg
t: +27 11 944 7265
e: pieter.visser@aonbenfield.com

Professor Andrzej Kijko
Aon Benfield Natural Hazard Centre Africa
t: +27 11 420 3613
e: andrzej.kijko@up.ac.za