Seismic Hazard and Risk of South Africa

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Организация Объединенных Наций по вопросам образования, науки и культуры

منظمة الأمم المتحدة للتربية والعلم والثقافة

联合国教育、科学及文化组织

African Union

Vunganai Midzi

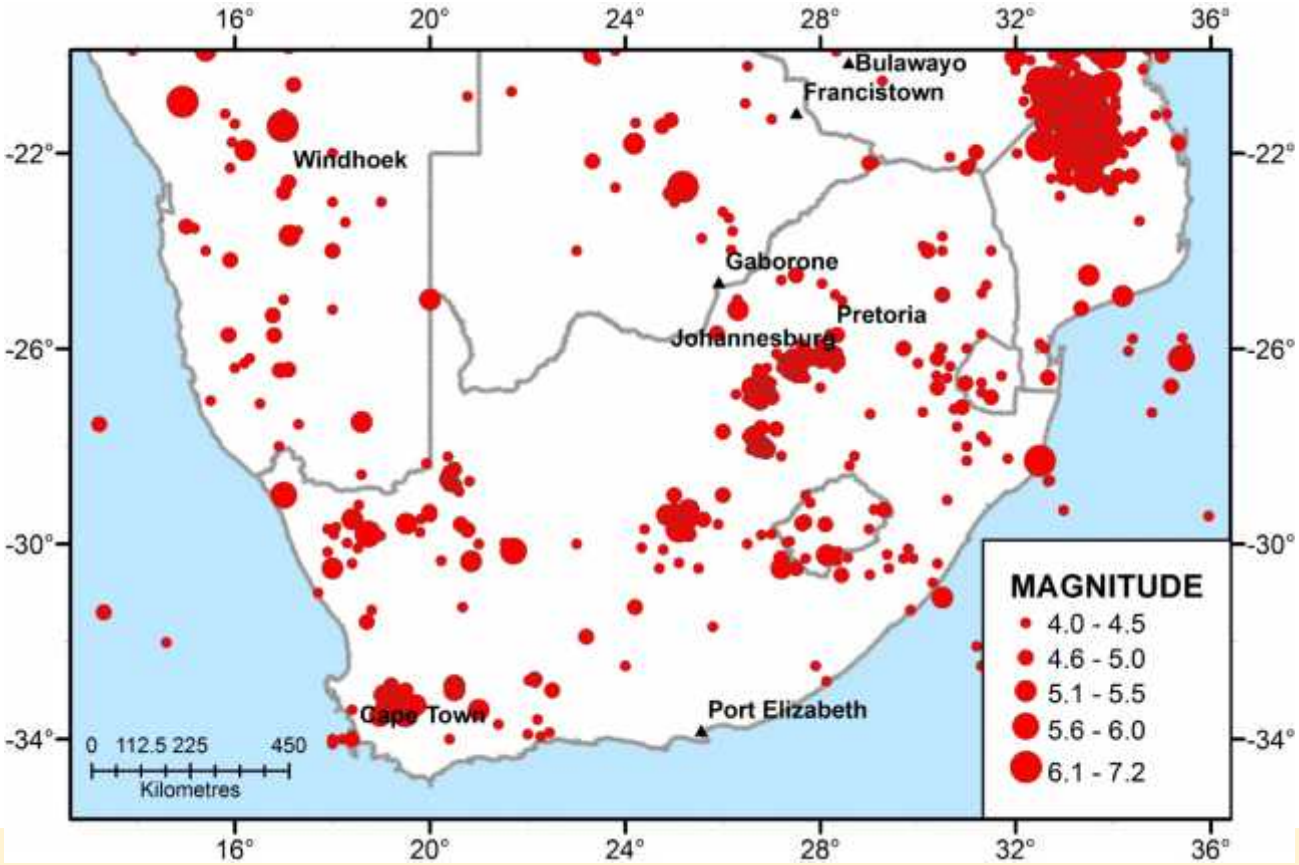
Council for Geoscience

Regional Update of Seismo-tectonic Map in Africa: A key component of Seismic Hazard and Risk Assessment

International Conference on Impact of Natural Hazards in Africa, Cairo, Egypt, 23 – 27 October 2017

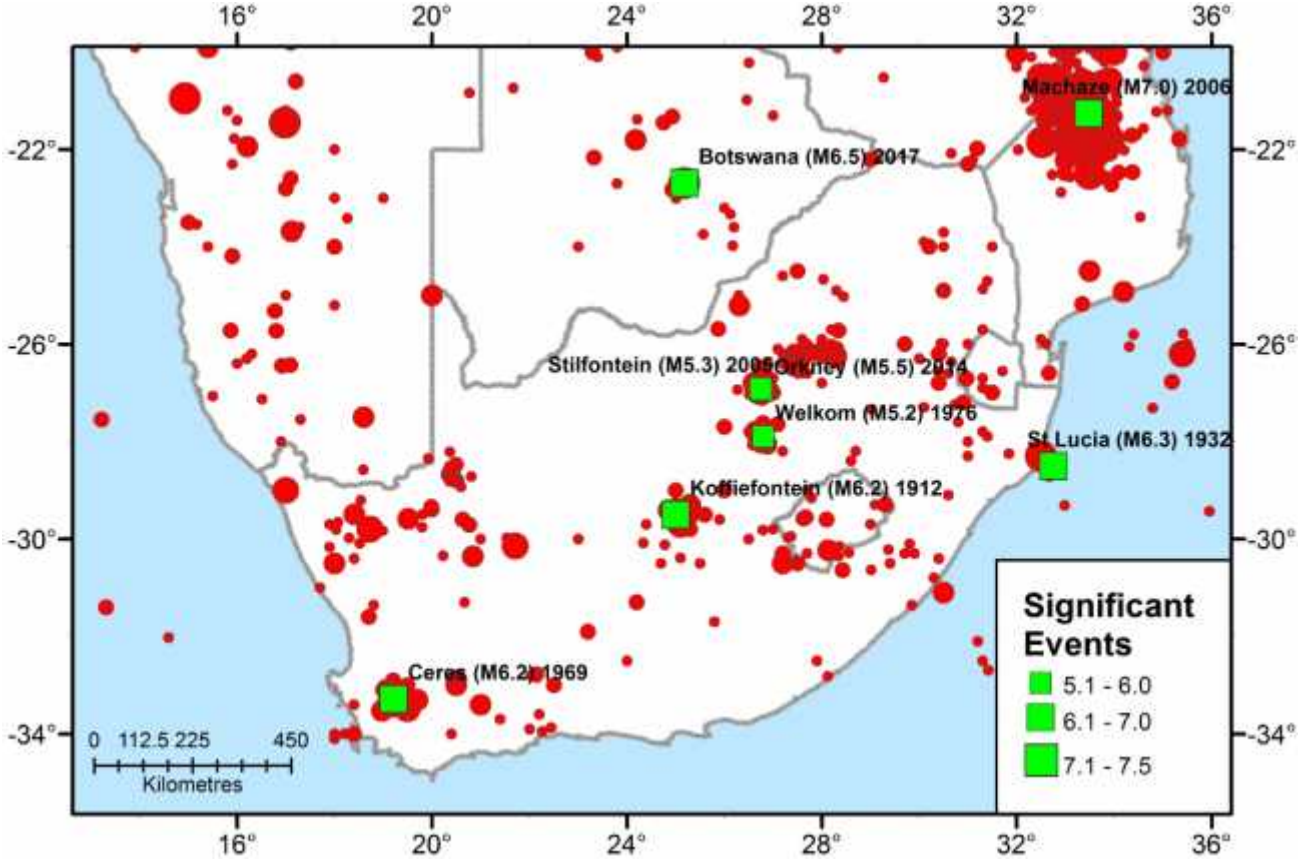
Introduction

As much as South Africa (& southern Africa) is considered to be located in a “Stable Continental Region”, earthquakes are recorded and located daily in the region.



Introduction: Significant Events

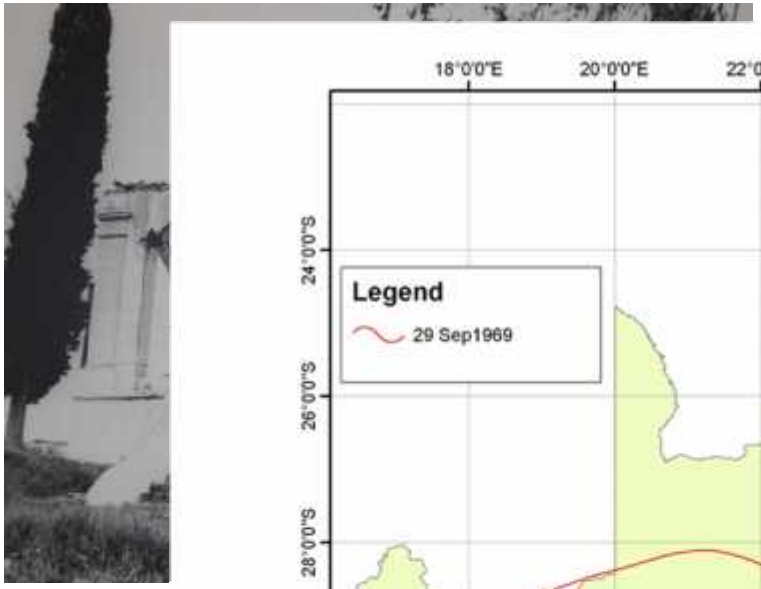
Severe earthquakes are occasionally felt.



Some of the most significant being:

- Koffiefontein, 1912
- St Lucia, 1932
- Ceres, 1969
- Welkom, 1976
- Stilfontein, 2005
- Orkney, 2014
- Machaze, 2006
- Botswana, 2017

1969 Ceres Earthquake



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2014 Orkney Earthquake

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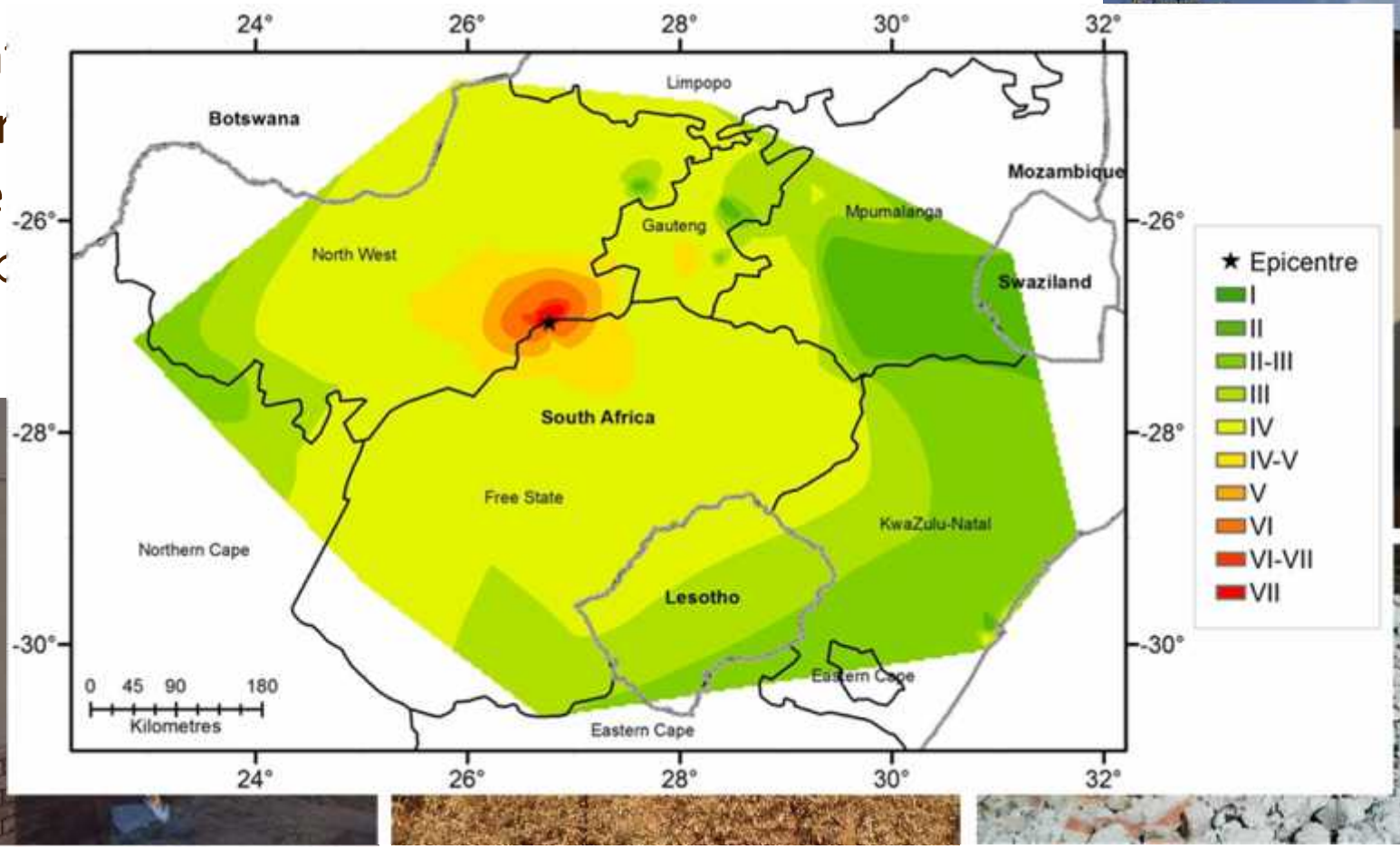
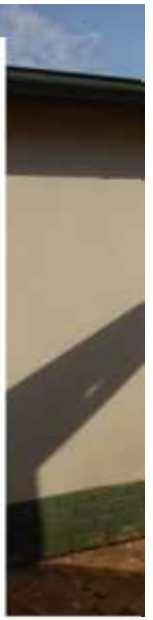




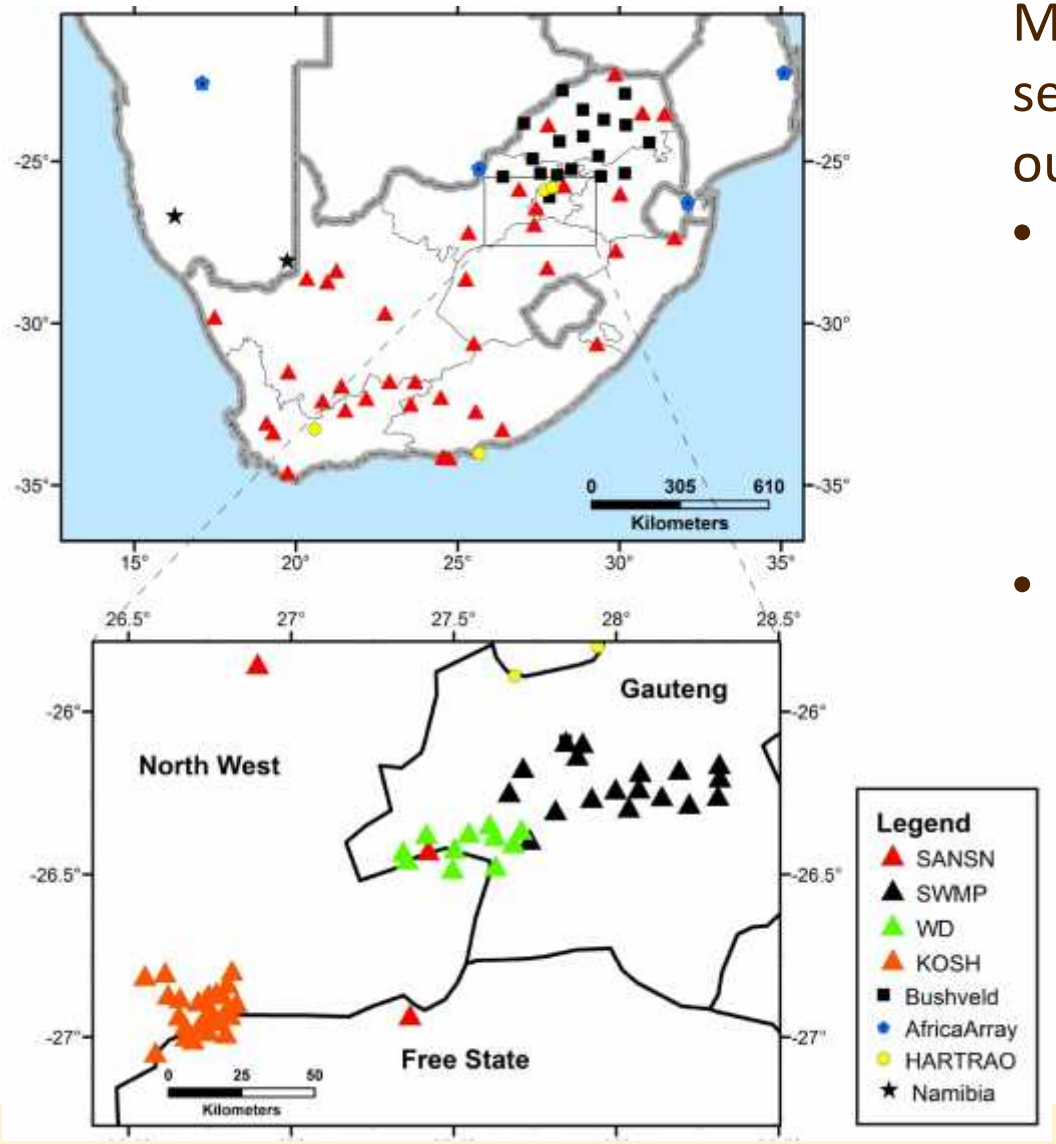
Collapsed wall under which a man was killed

Mitigation of Hazard

To be prepared:

- Safe structures by designing according to seismic design guidelines
- Should be aware of protective actions.
- Understand sources and effects of earthquakes including carrying out reliable

Mitigation: Seismic Monitoring

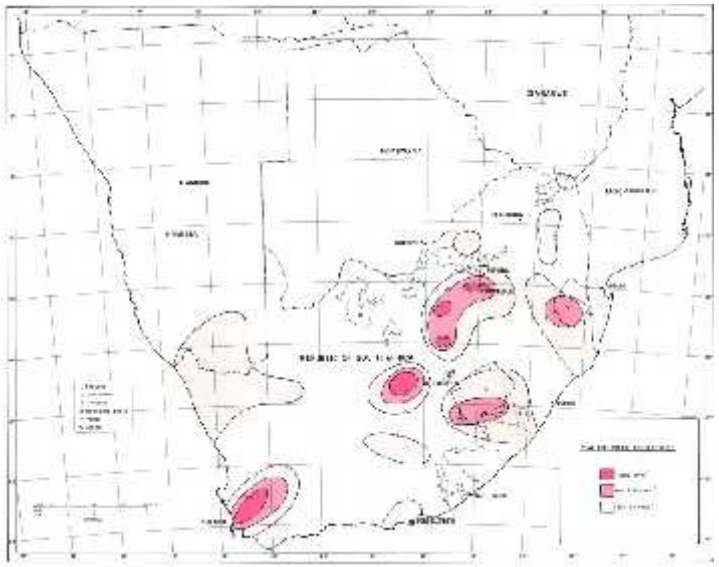


Main tool is the monitoring of seismic events within and also outside South Africa

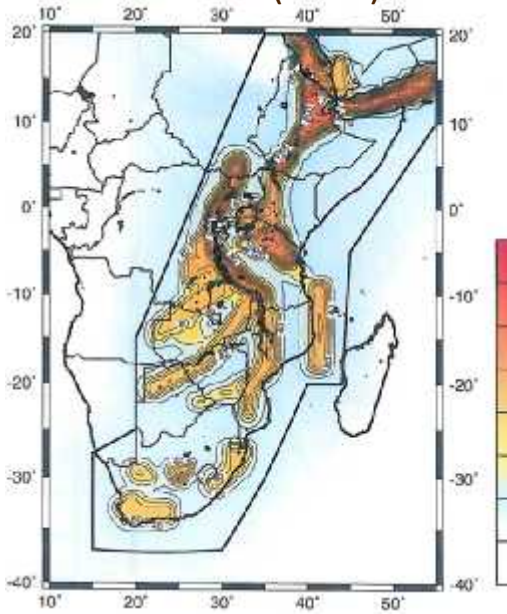
- National network (includes access to data from other stations from outside SA & AfricaArray Stations – Bushveld Complex)
- Cluster networks (Concentrates on monitoring events in the Gold mining regions in Gauteng and North West Provinces)
  - Hope to start installing cluster network in the Platinum mining belt (80 stns)

SHA in SA

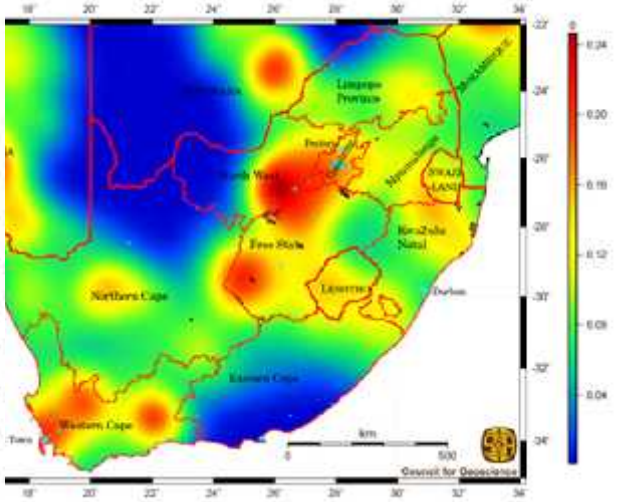
Fernández & du Plessis (1992)



Midzi et al. (1999)



SA Building Codes (Kijko 2003)



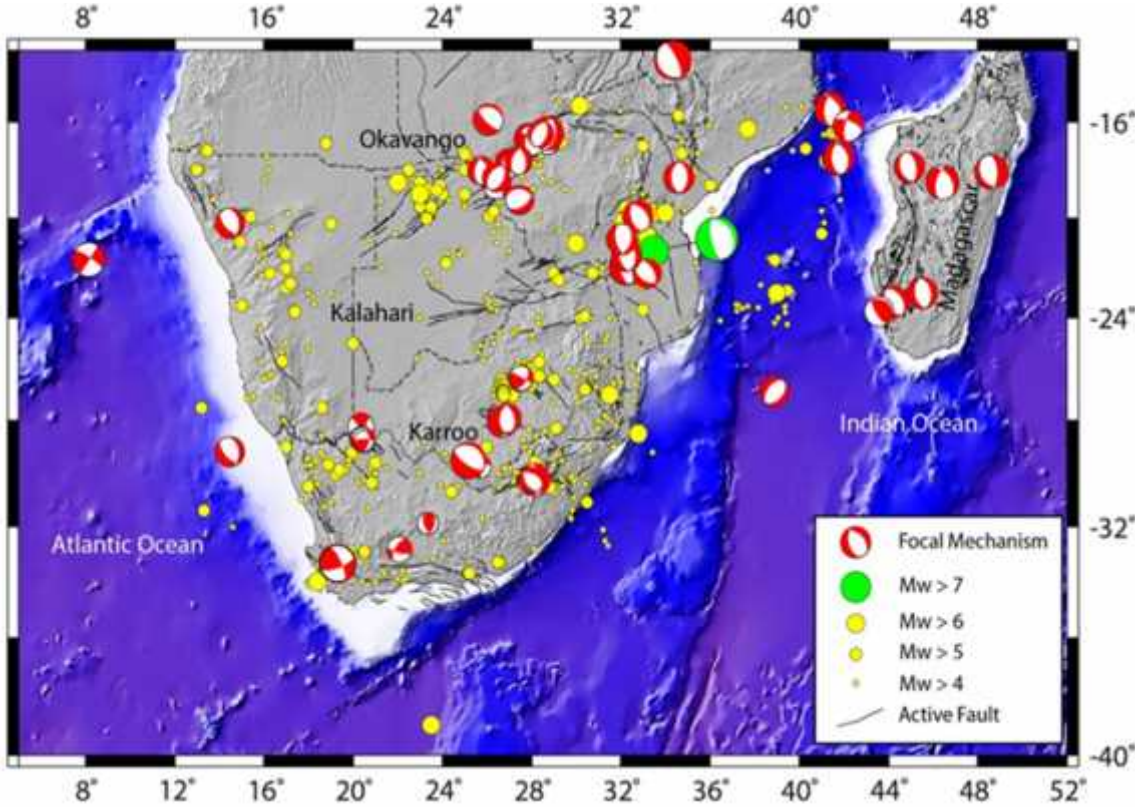
In addition to effective monitoring of earthquakes in the region, efforts have been made to conduct hazard assessments.

- Fernández and du Plessis (1992) map is the current official CGS national seismic hazard map.
- Apart from GSHAP map, other maps based on zone-less technique.
- GSHAP map excluded induced event (mines) sources.

SHA: Justification for New Map

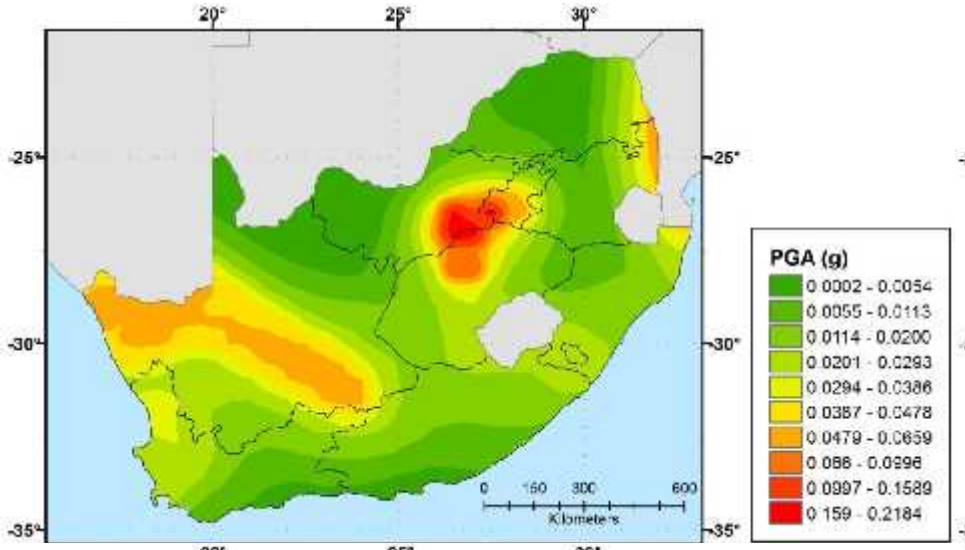
- Hazard maps due for upgrade (Also need to be published)
- Methodology
  - PSHA with sources
  - Accounting for uncertainties using logic tree method
- Internationally recognised software
  - OpenQuake
- **Data**
  - Improved quality and quantity of data
  - Seismotectonic map – IGCP601

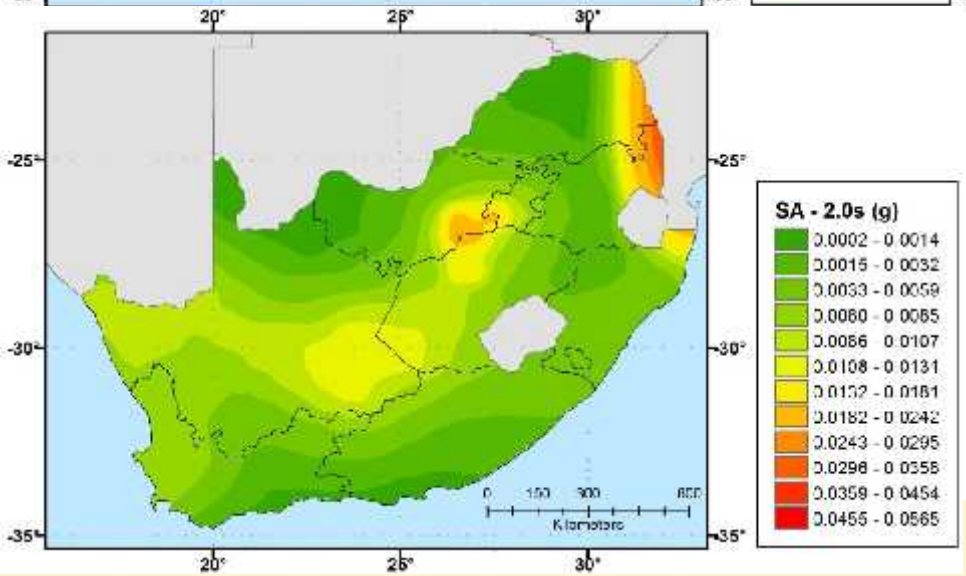
SHA: Seismotectonic map

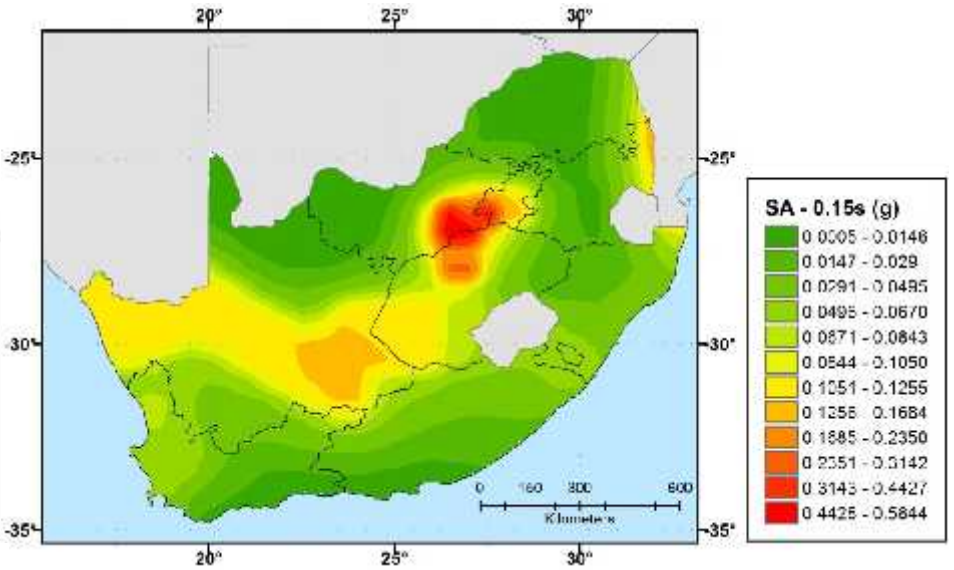


- The regional Seismotectonic Map and associated database from the IGCP601 Project was crucial in preparation of sources.
- Data used to identify and delineate seismic source zones.
- Other data include:
  - Past studies (Bommer et al., 2014; Brandt, 2008; Singh et al., 2011; Hartnady, 1985; Geological studies)

Mitigation: Seismic Hazard Assessment





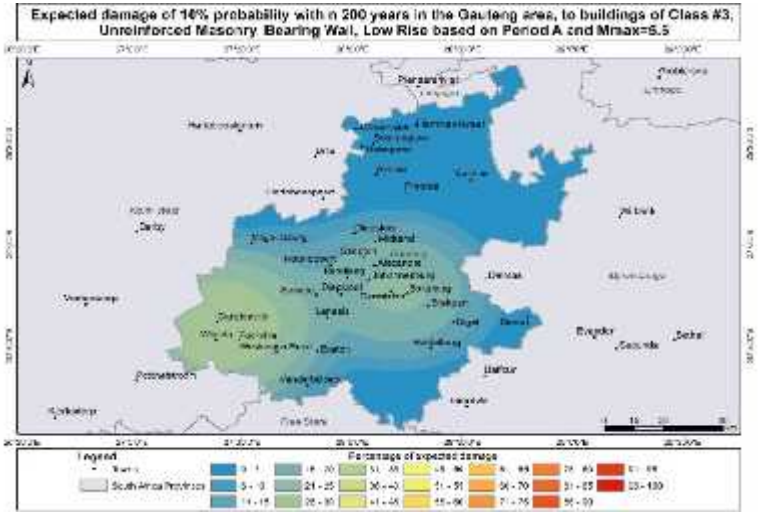


- Article on SHA of SA currently under review at JOSE
- About to complete microzonation studies of Johannesburg and North West Province main cities
- Recently started working on microzonation of KZN province main cities.

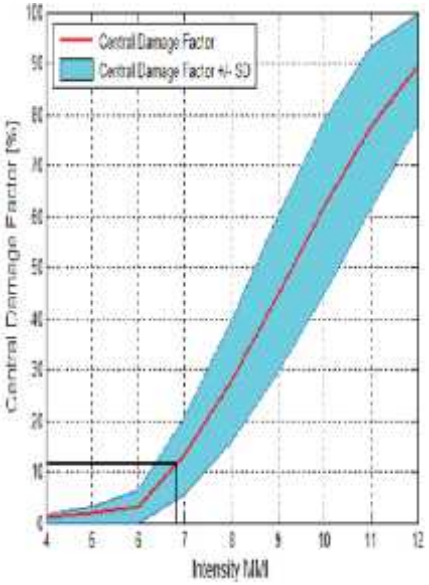
Mitigation: Seismic Risk Assessment

- Assessment of expected damage during specified time interval
- Only a few such studies have been carried out in South Africa, (e.g. Pule et al., 2015 for Sandton, Cape Town, Durban & Port Elizabeth as an MTech project; Kijko et al., 2002, 2003 for Tulbagh; Davies & Kijko, 2003, Kijko et al., 2017 mainly for the insurance industry in Johannesburg

Building class # 3: Unreinforced Masonry, Bearing Wall, Low Rise (most vulnerable class)



Kijko et al. (2017) for Johannesburg



Pule et al. (2015) for Sandton (Johannesburg)

Mitigation: Seismic Risk Assessment

Important Input Data

- Complete Building classes for the country

Of the 12 types of buildings identified mostly the following three types are found in major SA cities (They represent about 70% of all South African urban structures):

Class #3 - unreinforced masonry, with load bearing wall, low rise.

Class #8 - reinforced concrete shear wall, without moment resisting frame, medium rise

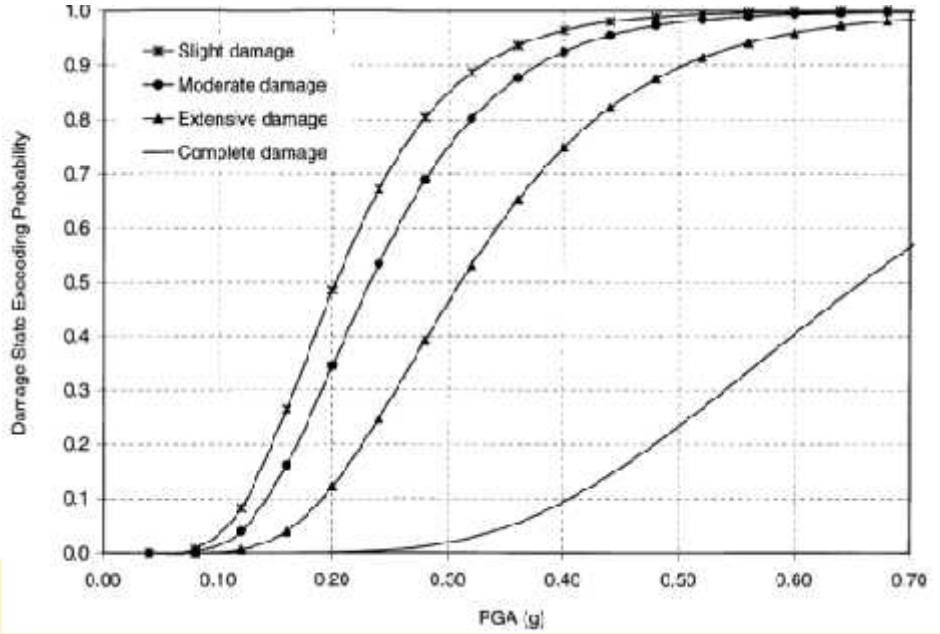
Class #9 - reinforced concrete shear, wall without moment resisting frame, high rise

So far risk assessed only for these three building types.

Seismic Risk Assessment

Important input data

- Damage curves
  - No damage curves which specifically adhere to local South African conditions.
  - Selected and used damage curves currently available in the world



Conclusion: Possible Impact of SEISMOSHAF

- It is clear from the work that has been done in our region that there is plenty of room to improve both hazard and risk assessments to effectively mitigate impact of earthquakes.
- More detailed investigations of active faults envisaged under SEISMOSHAF will help in improving seismic source models (faults used as input in SHA instead of just area sources) – PhD candidate
- GMPEs derived specifically for our regions
- Site effect studies to help produce more realistic results
- Development of damage curves which specifically adhere to local conditions – PhD candidate
- Compilation of full information on building classes in our region and available information on damage to infrastructure.

THANK YOU