Australia's National Science Agency

LAND AND INFRASTRUCTURE

GISERA | Gas Industry Social and Environmental Research Alliance

Investigating the baseline seismicity of the Beetaloo Sub-basin in the Northern Territory

CSIRO scientists have completed a research project investigating the baseline seismic activity levels within the Beetaloo Sub-basin and its nearby surroundings in the Northern Territory.

This project, conducted through CSIRO's Gas Industry Social and Environmental Research Alliance (GISERA), deepens our understanding of seismic activity across the Beetaloo Sub-basin.

Gathering baseline data about earthquake activity in the region is essential so that any increased in seismic activity that result from gas development in the region can be clearly identified.

The project also used physics-based ground motion computations to estimate the ground shaking at any point within the Beetaloo Sub-basin caused by a hypothetical but realistic earthquake scenario in the region.

The Beetaloo Sub-basin

The Beetaloo Sub-basin lies southeast of Katherine in the Northern Territory and spans approximately 28,000 square kilometres. One of the most prospective areas for shale gas production in Australia, the estimated gas resources for the Beetaloo Sub-basin are of similar size to other major gas producing basins, such as the Surat Basin in Queensland and the Bonaparte/Browse basins in Western Australia.

In 2018, GISERA partnered with the NT Government to deliver independent and transparent research on gas development.

If an onshore gas industry is developed in the Beetaloo, it is expected that hydraulic fracturing technologies will be used. This process may create weak seismicity as fluids are injected at high pressure into target rock formations.

As the background seismic activity of the Beetaloo Sub-basin remains largely unknown, this project was designed to help close that knowledge gap and provide a useful baseline to inform and support future decision making.

Key points

- Researchers analysed a five-year dataset recorded by Geoscience Australia's seismic monitoring array in the Beetaloo region.
- They investigated both natural seismic activity and human-induced activity such as quarry blasts.
- For data collected between 2019 and 2024, no natural seismic activity was detected.
- The project team also trialled a physics-based simulation method to estimate ground shaking in the region from a hypothetical earthquake scenario.
- The report identifies a densely located seismic array as an option for future monitoring of seismic activity in the region.

Gathering and analysing seismic data

Researchers first identified potential sources of seismic activity by mapping the available spatial data, including the locations of major roads, active mine sites and petroleum wells.

They then assessed seismic stations that are operated across the Beetaloo Sub-basin by Geoscience Australia (GA) by analysing quarterly seismic noise variations – one of the parameters that determines the detection sensitivity of a seismic station.

The project team examined seismic data (waveforms) recorded across the GA network over a five year period (2019–2024) for local, regional and distant earthquakes. Using state-of-the-art methods, they detected only man-made seismic activity within the region.

While this could be due to a real lack of seismicity, the report notes that the lack of recorded natural seismic activity could also be due to the sparse distribution of the GA seismic array.

Ground motion simulations

Although natural earthquake activity in Australia is relatively low compared to regional neighbours like Indonesia, large magnitude earthquakes can occur with very long recurrence rates, making risk calculations challenging.

For example, in 1988, three consecutive large earthquakes occurred in the south of the Beetaloo Sub-basin. Prior to these, only moderate seismicity was observed in 1987, and no other significant seismic activity was observed in the recorded history.

In these circumstances, ground motion simulations can be a useful way to assess the potential physical impacts induced by earthquakes, including on infrastructure and communities.

For this project, researchers simulated wave propagation for a hypothetical yet realistic earthquake scenario: a 5.1 magnitude earthquake occurring 300km south of the Beetaloo seismic array. This allowed them to evaluate the influence of geological structure on expected natural seismicity.

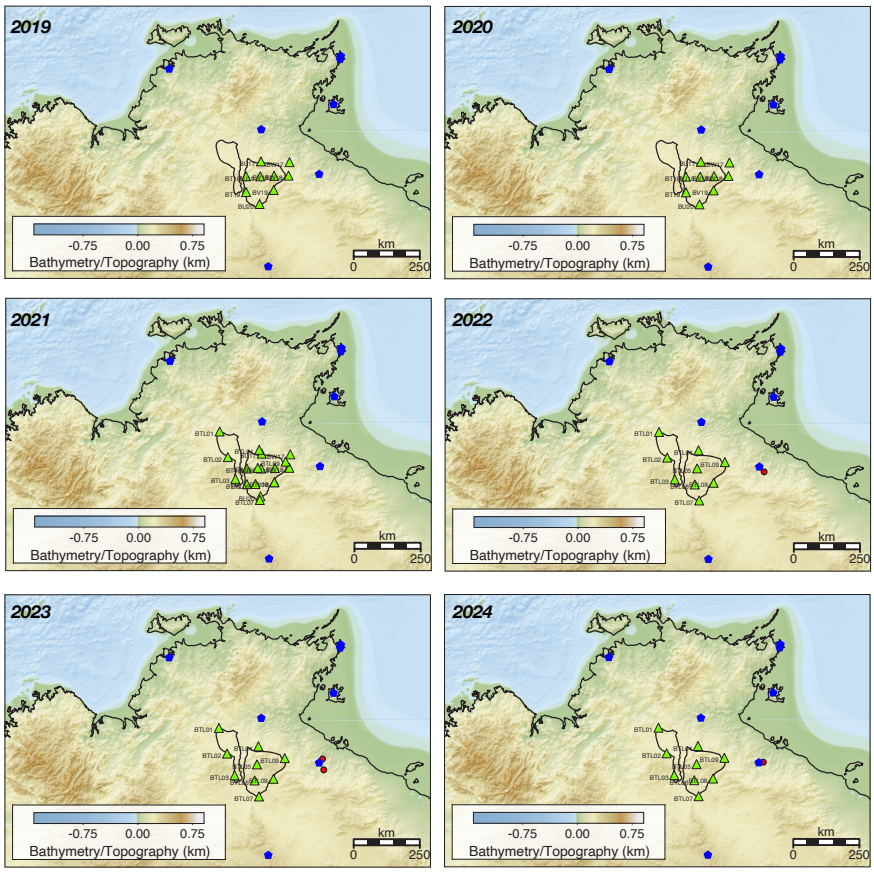
Future work and recommendations

A key finding from this project is that overall seismic noise levels in the Beetaloo Sub-basin remain low, with minimal seasonal variation.

However, the report concludes that with the relatively long recurrence rates of large magnitude earthquake activity across Australia, it will be important to continue seismic monitoring with a tightly clustered network in the Beetaloo Sub-basin to properly quantify the seismic risk. A recommendation is made for an optimum seismic network design.

The research team also propose to examine the surface imprints of previous large earthquake activity in the region by analysing satellite-derived digital elevation models.

By coupling these two classes of information, scientists will be able to more effectively and accurately characterise the natural seismic risk of the region.



Yearly evolution of the Beetaloo Seismic array and also detected non-seismic events between 2019 and 2024. The locations of the detected events are marked with red circles. Green triangles indicate the locations of the Beetaloo Seismic Network stations, and blue pentagons show the active mine sites. The McArthur River Mine is located near the red circles. The background topography and bathymetry are derived from ETOPO1 (Amante et al., 2009).

More information

Read more about this project

Learn about other GISERA research in the Northern Territory

Find out more about GISERA's land and infrastructure research

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