A pilot time-lapse field survey was carried out near Dalby using microgravity (MG), electrical resistivity tomography (ERT) and self potential (SP) during irrigation pumping, from 23 Sept to 13 Oct 2015.

Changes in the subsurface due to pumping are related to changes in mass (MG), changes in resistivity (ERT) and changes in fluid flow (SP). Measurements are surface-based and could provide a cost-effective alternative to well-bore monitoring for the resource industry.

This pilot study evaluated the applicability of the various methods to approximately evaluate shallow aquifer characteristics. Modelling results indicated that certain combinations of non-seismic methods, at certain geological conditions, can result in sufficient imaging fidelity to provide a lower cost monitoring alternative to well-based approaches.

### Table 1: Applicability of various non-seismic methods for CSG activity monitoring

<table>
<thead>
<tr>
<th>groundwater integrity</th>
<th>stimulation effectiveness</th>
<th>reservoir performance</th>
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<tbody>
<tr>
<td>MG</td>
<td>ERT</td>
<td>SP</td>
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- **Microgravity** (MG) (density)
- **Self-Potential** (SP) (fluid flow)
- **DC Resistivity** (resistivity) (density)

**COMBINED MODFLOW/GRAVITY MODELLING**

**FIELD SITE & GEOLOGY**

**PILOT SURVEY**

**SUMMARY & OUTLOOK**

- A pilot field survey was carried out to assess the applicability of various non-seismic potential field techniques for aquifer characterisation.
- A hybrid microgravity survey was completed using a CG-5 relative and An-A10 absolute gravimeter. The data from the A-10 looks cleaner, but the data from the CG-5 exhibits more features due to higher sensitivity. In both datasets, the aquifer drawdown is observed.
- Time-lapse ERT could demonstrate the change in electrical resistivity associated with irrigation pumping from the Alluvial Aquifer.
- Based on the microgravity datasets, specific yield (effective porosity) can be estimated and based on the ERT datasets, hydraulic conductivity (effective permeability) can be estimated.

**ABSTRACT**

**FIELD DATA INITIAL RESULTS**

**Fig 6** (a) 180° image of survey site with the farmer’s diesel engine and tank for the irrigation pump on the left; (b) remote monitoring wells and geophysical field equipment to the right; (b) relative gravity measurements using a CG-5 instrument; (c) absolute gravimeter A-10, on loan from Geoscience Australia and GPS base station; (d) field site; (e) resistivity cable and electrodes; (f) irrigation channel and pipes to flood the paddocks; (g) landscape view of field site with irrigation channels and paddocks; (h) water pumping from the Condamine Alluvial Aquifer and Molly, the farmer’s dog, taking a bath.

**Fig 7** Microgravity measurements for absolute (A-10) and relative (CG-5) gravimeters. The absolute gravity data shows a sharp decline on the 3rd day after pumping associated with the drawdown of the aquifer. A slow rise from the 5th day is understood to be due to flooding of irrigation channels and the paddocks, where the southern paddock and channel were closest to STN05. After pumping stopped various responses might be attributed to paddock drying and aquifer recovery. The relative gravity data on the right shows analogous but more complicated behaviour due to a higher noise level and higher sensitivity of the instrument.

**Fig 8** Result of Time-Lapse inversion of electrical resistivity data acquired in the core region (top) and along the access road (c.f. figure 5) using a Wenner layout. The images show the relative change in resistivity during 10 days of pumping with respect to a baseline measurement which was done before pumping commenced where all data sets are inverted simultaneously. In both images the main changes are centred around the well bore and in 10m depth coinciding with the sand layer. (Thanks to MSc student Taruna Fadillah)