Impact of Deformation on the Spatial Cadastre
Nic Donnelly | Geodetic Surveyor

Contents

• Significant earthquakes 2000-2012
• Impact on digital spatial cadastre
• Handling earthquake deformation
• The South Island Update
• Publishing the deformation model
### Significant earthquakes 2010-2012

<table>
<thead>
<tr>
<th>Name</th>
<th>Date</th>
<th>Magnitude</th>
<th>Max H</th>
<th>Max V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Secretary Island</td>
<td>22 Aug 2003</td>
<td>7.2</td>
<td>0.27</td>
<td>0.72</td>
</tr>
<tr>
<td>(Fiordland)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Macquarie Island</td>
<td>24 Dec 2004</td>
<td>8.1</td>
<td>0.015</td>
<td>0.005</td>
</tr>
<tr>
<td>George Sound</td>
<td>16 Oct 2007</td>
<td>6.7</td>
<td>0.13</td>
<td>0.27</td>
</tr>
<tr>
<td>(Fiordland)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dusky Sound</td>
<td>15 Jul 2009</td>
<td>7.8</td>
<td>1.74</td>
<td>0.39</td>
</tr>
<tr>
<td>Darfield</td>
<td>4 Sep 2010</td>
<td>7.1</td>
<td>3.20</td>
<td>1.75</td>
</tr>
<tr>
<td>Christchurch</td>
<td>22 Feb 2011</td>
<td>6.3</td>
<td>0.31</td>
<td>0.48</td>
</tr>
<tr>
<td>Christchurch</td>
<td>13 Jun 2011</td>
<td>6.3</td>
<td>0.22</td>
<td>0.13</td>
</tr>
<tr>
<td>Christchurch</td>
<td>23 Dec 2011</td>
<td>6.0</td>
<td>0.25</td>
<td>0.36</td>
</tr>
</tbody>
</table>

Max H and Max V are maximum horizontal and vertical displacements across the land area of New Zealand in metres.

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Land movements

• NZ spatial vs legal cadastre
• Landonline database
• Drivers for update
  - Coordinates that reflect location
  - Closely represent legal boundary position (but don’t need a perfect match)
  - Consistency with other geospatial data (eg imagery)

Impact on Spatial Cadastre
Coordinate requirements

Locally accurate

Stable

Current

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**Geophysical fault model**

How are patches calculated

- Based on geophysical models determined by GNS Science
- Trial fault model based on seismic and geological evidence
- Final model calculated by mathematical inversion of surveyed surface displacements
- Data from GPS campaigns, CORS station time series, InSAR data
- Model used to calculate surface displacement on a grid of points that defines the patch deformation.
Patches as nested grids

<table>
<thead>
<tr>
<th>Grid</th>
<th>No Lon</th>
<th>No Lat</th>
<th>Size Lon (deg)</th>
<th>Size Lat (deg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>52</td>
<td>54</td>
<td>0.15</td>
<td>0.125</td>
</tr>
<tr>
<td>B</td>
<td>50</td>
<td>59</td>
<td>0.075</td>
<td>0.0625</td>
</tr>
<tr>
<td>C</td>
<td>84</td>
<td>118</td>
<td>0.0375</td>
<td>0.03125</td>
</tr>
<tr>
<td>D</td>
<td>141</td>
<td>306</td>
<td>0.01875</td>
<td>0.015625</td>
</tr>
</tbody>
</table>

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Changes to NZGD2000 coordinates

Landonline updates
- 7,876,563 coordinates
- 2,215,410 nodes
- 2,745,690 lines
- 543,787 parcels
- 48,629 roads

Cadastral layers only updated where the change is greater than 5cm

Applying the patch in Landonline

Geodetic surveys

Cadastral surveys

Normal update process

Adjustment

Coordinate updates

Spatial updates parcels, roads...

Patch update
Updates to coordinate uncertainties

- Model contains uncertainties, which should be reflected in updated coordinates
- Model only incorporates deep-seated movement, areas of shallow movement will have coordinates that disagree with object location

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Publishing the model

- Published as a zip file containing a set of CSV files in a defined structure
- Includes documentation and (python) example code for calculating the deformation at any epoch
- Current version is 20150101 – includes deformation caused by Cook Strait and Lake Grassmere earthquakes
Publishing the coordinate update

The coordinate update.

• CSV file format:
  - Complete definition of coordinate change
  - Not supported by any software tools

• NTV2 format:
  - Usable by GIS software (e.g., ArcGIS) and open source tools (e.g., ogr2ogr).
  - Does not handle vertical deformation

Please place in your calendar 2 – 6 May 2016