The Practical Limitations of a Semi-Dynamic Datum – Is There a Better Solution

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Contents

- The role of a national geodetic datum
- Handling tectonic movement in NZGD2000
- Accuracy limitations
- The future for NZGD2000
  - Is there a better solution? or
  - Will it satisfy spatial user needs into the future?

The role of a national geodetic datum – has it changed?

The National Geodetic Datum is dead!

Long live the National Spatial Reference System
Everything is moving!

NZGD2000 – semi dynamic datum?

**NZ Geodetic Datum 2000 (NZGD2000)?**

or is it


- Plate fixed local coordinate system
- Defined in relationship to ITRF1996
- Includes a time dependent deformation model
  - Enables the transformation to and from other reference frames (eg ITRF, WGS84)
- Can be considered as a series of datums as the deformation model changes
- Provides a convenient means of defining coordinates of physical spatial features that are independent of epoch
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The secular velocity model
What the velocity model does for spatial referencing

Earthquake!!
Deformation due to earthquake

Deformation model patch

<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>60</td>
<td>59</td>
<td>0.075</td>
<td>0.0625</td>
</tr>
<tr>
<td>C</td>
<td>64</td>
<td>118</td>
<td>0.0376</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>
Events effecting the South Island of New Zealand since 2000

<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>0.02</td>
<td>0.01</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>
<tr>
<td>Cook Strait</td>
<td>17 Jul 2013</td>
<td>6.5</td>
<td>0.08</td>
<td>0.02</td>
</tr>
<tr>
<td>Lake Grassmere</td>
<td>16 Aug 2013</td>
<td>6.6</td>
<td>0.34</td>
<td>0.26</td>
</tr>
</tbody>
</table>

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

Two options for patching

<table>
<thead>
<tr>
<th>“Forward” patch</th>
<th>“Reverse” patch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coordinates unchanged</td>
<td>Coordinates changed to reflect deformation due to earthquake</td>
</tr>
<tr>
<td>Need to apply patch to convert current coordinates ITRF⇔NZGD2000</td>
<td>Only need to apply patch to convert coordinate for dates before the earthquake</td>
</tr>
<tr>
<td>Relative local accuracy degraded (for current coordinates)</td>
<td>Relative local accuracy maintained</td>
</tr>
<tr>
<td>Simple to implement – only changes deformation model, most users unaffected</td>
<td>Costly to implement – coordinate change applies to all databases of NZGD2000 coordinates in affected area</td>
</tr>
</tbody>
</table>
Reverse patch coordinate update

What patches do for spatial referencing
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Distortion of reference system

![Distortion Map of New Zealand](image)
Unmodelled deformation
Example: Slow slip events

Latency

Deformation model is not available immediately after event such as earthquake.
May wait until frequency of events has tailed off, or immediate post-seismic movement has subsided
Delayed by acquisition of post event data and time for analysis and implementation
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Other sources of data – direct measurement of deformation
Vertical deformation?

Take home messages

- For high accuracy scientific applications ITRFxx will be used
- NZGD2000 will remain a very useful spatial reference frame focused on providing a geospatial infrastructure for New Zealand geospatial community rather than a scientific geodetic datum
- NZGD2000 will continue to meet the needs of this community for the foreseeable future
  - It will be simpler to convert real time positions in terms of ITRFxx or WGS84 to NZGD2000 than to continually update geospatial datasets to track realisations of the ITRF and WGS84
  - It will be simpler to make the corrections at the positioning data source and transform them to the geospatial reference frame – NZRF2000
- Transformation of GNSS derived coordinates in terms of global reference frames (ITRF, WGS84) to NZRF2000 is time dependent and is precisely defined by the deformation model
- Future earthquakes will be addressed in NZGD2000 datum by new versions of the deformation model
- Good time/datum metadata on spatial information is essential if sub-metre spatial accuracy is a concern.
- NZRF2000 will continue to meet the spatial community needs into the future
Questions?