Re-establishing the geodetic system after the 14 November 2016 Kaikoura earthquake

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Key points

• Rapidly assess earthquake impact on geodetic system
• Fast re-establishment of base level of horizontal and vertical control
• Empower surveyors to generate their own control where and when they need it
New Zealand’s tectonic setting
New Zealand Geodetic Datum 2000

- Coordinates are fixed, except after an earthquake
- Deformation model manages tectonic movements
- New versions of deformation model published after earthquakes or when new data is available
New Zealand Vertical Datum 2016

- Heights referenced to the quasigeoid
- Model provides offsets between ellipsoid and quasigeoid
- Users primarily access the datum via GNSS ellipsoidal heights
Kaikoura earthquake

• Magnitude 7.8, 14 November 2016
• Multiple faults ruptured
• Displacements exceeding 5m (horizontal and vertical)
• Serious property and infrastructure damage
Determining approximate size and extent – GNSS and InSAR
Surveying post-earthquake geodetic control

- Initial focus on existing geodetic marks in urban areas
- Objective to survey as many marks as possible in a short timeframe
- 4-hour plus 1-hour GNSS occupations at base station in each locality
- Other marks surveyed with RTK
Data processing and displacement estimates

• High-precision base station coordinates from PositioNZ-PP online processing service
• Other coordinates from RTK or fast static processing
• Displacements calculated using the SNAP least squares software

http://www.linz.govt.nz/positionzpp
Publishing post-earthquake data

NZ Kaikoura Earthquake (14 Nov 2016) Geodetic Marks
LINZ / National Geodetic Office

nod_id: 36766080
code: APKE
mark_name: SS 388 (HENDERSON STREET)
datum: NZGD2000
datum_version: v20160701
coord_epoch: 2016-11-23 00:00:00
lat_dd: -41.504382393
lon_dd: 173.972682545
lat_dms: 41°30'15.77661"S
lon_dms: 173°58'21.65716"E

https://data.linz.govt.nz/layer/3527
Guidance to surveyors generating their own control in affected areas

- Webpage set up covering:
  - Post-earthquake control survey methodologies
  - How to reference coordinates
  - Land movement maps

<table>
<thead>
<tr>
<th>Local (vector between control marks)</th>
<th>Network (coordinate in terms of PositioNZ stations)</th>
<th>Height accuracy (95% confidence level) (m)</th>
<th>Minimum distance between control marks (m)</th>
<th>Minimum time for each occupation (2 occupations for each mark required) (hours)</th>
<th>Order</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td>East and north accuracy (95% confidence level) (m)</td>
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<td>NZGD2000</td>
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</table>
Importance of metadata when the land is still moving

• Record the coordinate epoch (date) and datum version
  – NZGD2000 may be updated several times due to ongoing movement.
  – Coordinate epoch is important as there is significant ongoing movement – coordinates will change
Next steps – deformation modelling and coordinate updates

- Geophysical model provided by GNS Science (New Zealand’s geoscience research agency)
- LINZ incorporating model into datum and assessing impact on coordinates, which will flow to other geospatial data
- Surveys and possibly deformation model updates will be ongoing
Summary

• Rapidly assess impact on geodetic system
• Fast re-establishment of base level of horizontal and vertical control
• Empower surveyors to generate their own control where and when they need it
Questions?