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Toitu te Land whenua Information New Zealand

Maintaining Accurate Coordinates after a Geodetic Datum Update

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Introduction

- Geodetic datum updates
- Geospatial dataset updates: Deterministic and stochastic models
- Geospatial dataset update techniques
- Case study: Updating the cadastre

Why Update Coordinates?

- Geospatial datasets often have high spatial accuracy (Network RTK makes this cheap and easy)
- Coordinates need to reflect reality. A future survey should be able to use coordinates to locate an object
- Users intuitively expect coordinates to at least maintain the level of accuracy they had when first surveyed
- May be a regulatory requirement to maintain coordinates in terms of a national datum to a certain level of accuracy

Geodetic Datum Update Scenarios

- Nationwide Datum Readjustment
- Local Geodetic Control Update
- Deformation Event

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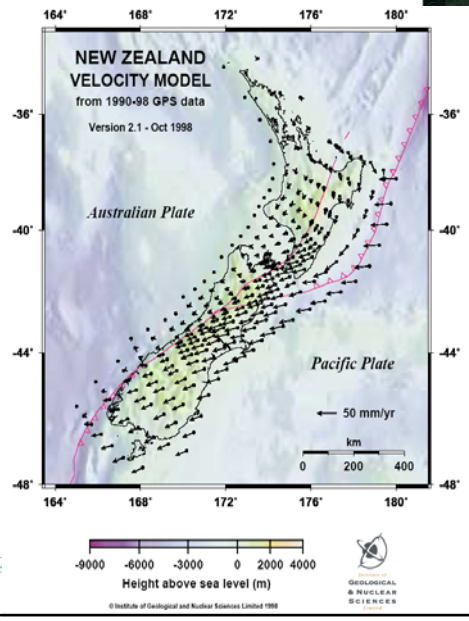
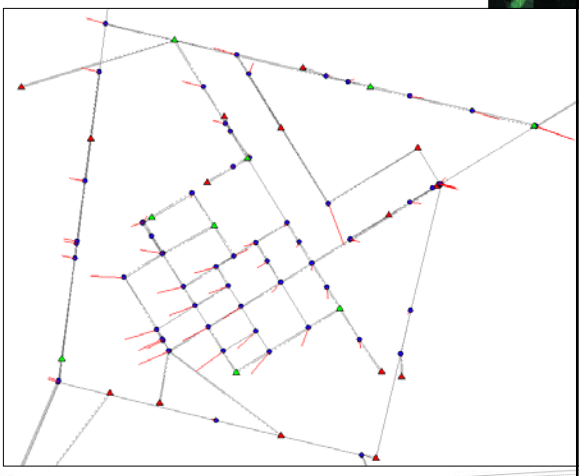
Datum Update - Nationwide

- New datum or reference frame
- Coordinate changes to fundamental stations
- New velocity model



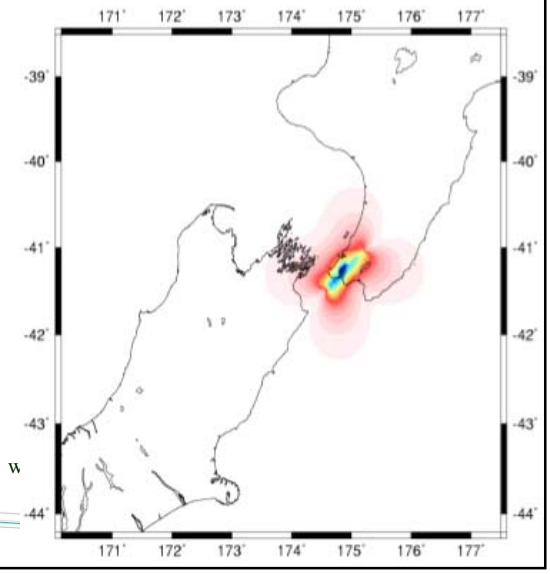
Datum Update - Local

- New geodetic control surveys
- Errors in existing work found and corrected
- Individual marks physically moved
- May be several updates to a given area



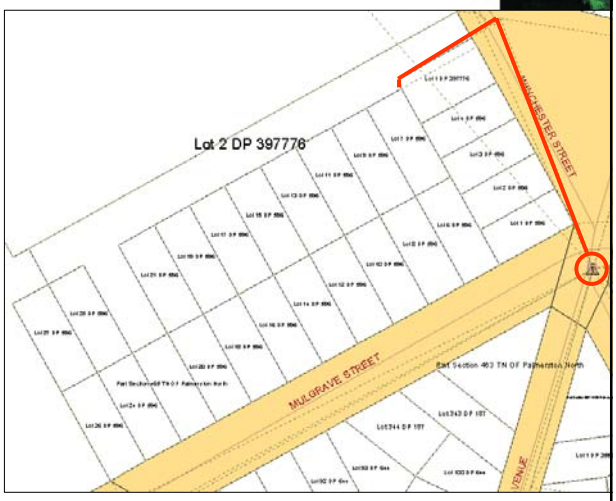
Datum Update – Deformation Event

- Can include earthquakes and slow landslides
- Potentially several metres of movement
- Affects a large geographical area
- Potentially regular updates required



Geospatial Datasets Connected to Geodetic Datum

- Only high-accuracy datasets need be considered
- Consider size of geodetic coordinate change in relation to dataset accuracy
- Only required if accuracy is to be maintained



Deterministic vs Stochastic Models

- There are two problems to be resolved:
  - Updating coordinates (deterministic)
  - Updating coordinate accuracies (stochastic)
- Need to update coordinates, wherever changes are significant
- We assume that the geodetic control is treated as 'fixed'
- This means the stochastic model for the geospatial dataset is independent of the stochastic model for the geodetic marks

Do We Need Accuracy Information?

Scenario	Situation	Geospatial dataset accuracy information needs updating?
1. Nationwide Datum Readjustment	New reference frame	No
	New National Deformation Model	No
	New or removed marks	No[1]
	New observations to existing marks (which have not physically moved)	No
2. Local Geodetic Control Update	New or removed marks	No[1]
	New observations to existing marks (which have not physically moved)	No
3. Deformation Event	New LDM	Yes
	New observations to existing marks (which have physically moved due to deformation)	Yes

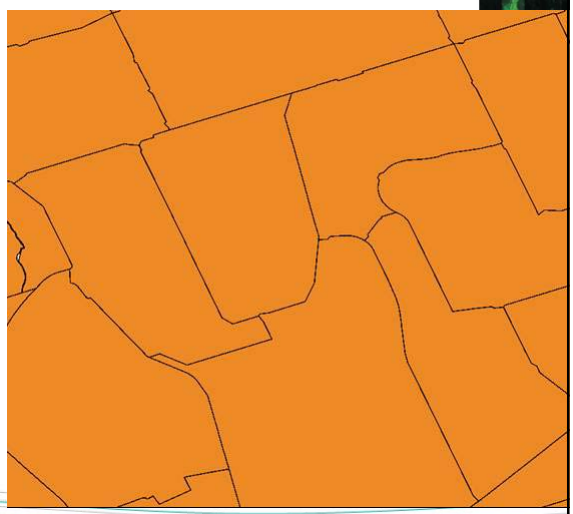
[1] Although an update may be desirable

Update Technique: Classical Least Squares

- Incorporates both deterministic and stochastic models
- Rigorous method of determining coordinates and accuracies
- Time taken to run an adjustment increases non-linearly with increasing number of stations (when full covariances calculated)

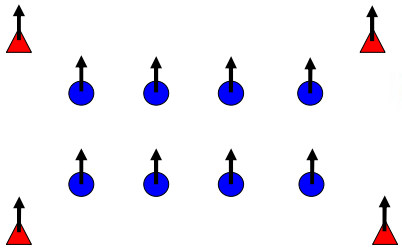
Update Technique: Block Least Squares

- Helmert Blocking
- Adjustment broken into smaller parts, increasing run speeds
- Incorporates both stochastic and deterministic models



Update Technique: Linear Interpolation

- Coordinates moved in proportion to movements at nearby control points
- Simple method, easily implemented
- BUT coordinates not as good as least squares
- Does not provide any accuracy information (deterministic model only)



Update Technique: Accuracy Function

- Accuracy assessment based on data characteristics
- Characteristics could include:
  - Proximity to geodetic control
  - Age of data
  - Equipment used to collect data
  - Physical characteristics of object being coordinated
- Cannot be used to update coordinates (stochastic model only)

Potential Techniques for Scenarios

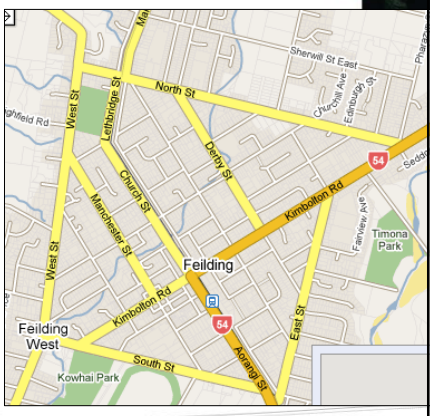
Scenario / Situation	Classical least squares	Block least squares	Inter-polation*
1. Nationwide Datum Readjustment			
New reference frame	x	x	√
New National Deformation Model	x	x	√
New or removed marks	x	√	x
New observations to existing marks (which have not physically moved)	x	x	√
Key √ = potential method • = potential method in some situations (eg small adjustments) x = not a feasible method			
*Assuming accuracy information, where required, is obtained from an Accuracy Function			

Potential Techniques for Scenarios continued

Scenario / Situation	Classical least squares	Block least squares	Inter-polation*
2. Local Geodetic Control Update			
New or removed marks	•	√	x
New observations to existing marks (which have not physically moved)	•	√	√
3. Deformation Event			
New LDM	•	√	√
New observations to existing marks (which have physically moved due to deformation)	•	√	√
Key √ = potential method • = potential method in some situations (eg small adjustments) x = not a feasible method			
*Assuming accuracy information, where required, is obtained from an Accuracy Function			

Case Study: Updating the Cadastre

- Several new geodetic marks surveyed, 60 others updated in Feilding, New Zealand
- Geodetic mark movements of up to 10cm, exceeding cadastral tolerances
- Affected cadastral network contains 7500 marks
- NOTE: Coordinates in NZ do not define boundaries



Case Study: Updating the Cadastre

- This is a Local Control Update with new geodetic marks. Although cadastral accuracy information does not need updating, in this case it is desirable to improve the utility of the cadastre
- We also have additional cadastral information since initial coordinates generated, which is useful to incorporate into the calculation of coordinates and coordinate accuracies

Case Study: Updating the Cadastre

- Block Least Squares is the appropriate technique for this geospatial update
- BUT practical considerations mean that in this case, each block was adjusted using classical least squares

Summary

- High accuracy (centimetre to decimetre) geospatial datasets should be considered for updating when a geodetic update occurs
- Need to consider size of geodetic coordinate shift in relation to accuracy of geospatial dataset
- Often the original accuracy information can be maintained, it is just the coordinates that need updating
- For accurate geospatial datasets, need to know how coordinates were derived OR retain connections (observations) to control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